ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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AN ENGLISH LOCOMOTIVE of the "Atlantic" type is the latest instance of the adoption of American features in foreign railway practice. The engine is one designed by Mr. H. A. Ivatt, Locomotive Superintendent of the Great Northern Ry., for handling heavy express trains. It has outside cylinders (slightly inclined) placed over the four-wheel truck, with the connecting rods attached to the rear driving wheels, the forward pair being driven by the coupling rods. The firebox is behind the driving axle, and is made much longer than is usual in English practice, the overhanging weight being carried by a pair of trailing wheels. The leading dimensions are as follows:

Driving wheels	6 ft. 6 ins.
Driving wheelbase	6 " 10 "
Cylinders	19 × 24 "
Converting rods	10 ft.
Boiler, diameter of barrel	4 "
Firebox, length	8 "
Tubes, length	13 "
Grate area	26.75 sq. ft.
Heating surface	1,442.00 " "

THE ELECTRIC LOCOMOTIVES for the London Central Underground Railway, described in our issue of June 9, differ from the electric locomotives of the Baltimore & Ohio R. R. in one important respect. The London engines have continuous frames and are mounted on two four-wheel swiveling, driving trucks. The B. & O. engines consist practically of two separate engines coupled back to back, each having two axles mounted rigidly in the frames, so that the pivoted truck system is eliminated. These latter engines were illustrated and described in our issue of July 11, 1895. The electric locomotive for the Hoboken Shore Line (Eng. News, Jan. 13, 1898), has continuous frames and is mounted on two four-wheel trucks. Although these three engines are for very different classes of service, it may be of interest to compare their general features.

	London Central.	Balt. & Ohio R. R.	Hoboken Shore R.R.
Service	Rapid transit.	Heavy freight and passgr.	Switching.
Length	30 ft. 0 ins.	35 ft. 0 ins.	29 ft. 0 ins.
Width	7 " 8 "	9 " 6¼"	8 " 0 "
Height	9 " 4½"	14 " 3 "	13 " 0 "
Wheelbase, rigid.	5 " 8 "	6 "10 "	5 " 6 "
" total	20 " 4 "	.. " .. "	18 " 2 "
Wheels, diameter.	3 " 6 "	5 " 2 "	3 " 3 "
Motors, number	4	4	4
" HP. total.	800	1,280	540
Speed,* m. per hr.	27	12 to 30	8
Weight, lbs.	84,000	192,000	57,000
Hauled, tons	105	1,200 to 1,900	295

*With load.

AN AUTOMATIC DRAWBAR HEIGHT ADJUSTER has been put upon the market by the Graham Equipment Co., of Boston, Mass., which is intended to be used in connection with the same firm's "equalizing brake-bar," by which the trucks are prevented from tilting when the brakes are released. An arm is attached to the brake equalizer, the end of which, coming up under the coupler body, raises it or permits it to drop as the load on the car varies. The equalizer itself is attached at one end to the truck frame and its center is fulcrumed upon the axle box so that its bar or cross piece moves upward as the weight of the car depresses the truck frame. A pamphlet published by the Graham Equipment Co. illustrates and describes the device quite clearly, but so far as we know it has not yet been tested to any extent in actual service.

THE INCLINED RAILWAY AT MT. LOWE, CAL., is operated by electricity obtained from generators driven by two Pelton wheels mounted upon the same shaft but driven by water from separate localities and under different heads. The high pressure wheel is 40 ins. in diameter and develops 100 HP. with a 1-in. nozzle and a head of 1,250 ft. The smaller wheel has a head of 287 ft., a wheel diameter of 19 ins. and two jets developing 50 HP., both wheels running at 800 revolutions per minute. This power is transmitted to the top of the incline, which is 3,000 ft. long, on a 48% grade, and there operates the cable machinery. The rails are used as a return for both the 500-volt power circuit and the primary circuit of the incandescent lighting system at 1,100 volts.

THE PHILADELPHIA ELECTRICAL EXPOSITION is now in good running order, and while it cannot compare with the exposition recently held at Madison Square Garden, New York city, as to size, number of exhibitors or completeness of exhibits, there is much of interest to be seen by the layman. The main floor is divided into two sections by a central fountain, and around the sides are arranged the artistically-decorated and well-lighted booths containing a variety of smaller devices and apparatus such as switches, cutouts, arc lamps, electric meters, fans, motors for pumps, printing presses, etc. On the second floor is a Turkish smoking room lit by Moore's vacuum tubes. The exhibition is under the direction of the following gentlemen and will continue until July 6: Wm. D. Marks, director; Arthur Falkenau, consulting engineer; A. A. Lowry, treasurer; Arthur Organ, Supt., and Guy King, architect.

MACHINERY COSTING $1,500,000 for a 6,000-HP. electric power plant is reported to have been ordered of a Pittsburg firm. The plant will derive its power from the Monte Alto River, near the City of Mexico, and the current generated will be transmitted to that city for light and power purposes. Mr. I. Sternefeld, of the firm of G. & O. Braniff & Co., is mentioned as the engineer of the enterprise.

SEVERAL JAPANESE OFFICIALS and college professors are in this country inspecting electrical apparatus and its manufacture. Among them is Massashi Namba, who is a professor in the Kioto University. He will remain in this country until Sept. 1.

THE TROLLEY LITIGATION has assumed a new aspect owing to the decision rendered by Judge Shipman, of Poughkeepsie, N. Y., who has decided the fundamental reversible trolley patent in favor of the Walker Co. and against the General Electric Co., with costs against the latter company.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the West Shore R. R., at Petty's Crossing, Rochester, N. Y., on June 9., due to spreading rails. One man was killed and five were injured.

A BLAST FURNACE EXPLODED at Lebanon, Pa., on June 5, as the result of molten iron leaking through the bottom of the furnace into the cooling water.

A SERIOUS EXPLOSION at the smelting plant of the Arkansas Mining Co., near Hatfield, Ark., is reported to have occurred June 11, in which 11 men were injured, several so seriously that they are expected to die. The accident was caused by a leak in a water jacket which allowed water to run in the ore pot.

A TORPEDO EXPLODED while being tested at Jacksonville, Fla., on June 10, killing two electricians and wounding a lieutenant of engineers, who was in the room at the time. It appears that in the course of the test a larger current than was intended was turned on by a mistake in cutting out resistance.

MUNICIPAL OWNERSHIP OF ELECTRIC WIRES, in Baltimore, Md., is to follow the ordinance passed by the Baltimore City Council, on June 10. This ordinance has been fought for the past six years by interested corporations. Uuder the ordinance the city is to build, own and operate subways for the electric wires, and overhead wires must come down. It provides for an Electrical Commission, empowered to construct the subways and to compel the taking down of all telegraph, telephone, electric light and feed wires, other than trolley wires. A Chief Engineer is appointed at $4,000 per annum, and the rentals are to be fixed by the Commission, subject to the approval of the Mayor and Council. All corporations or persons using the subway must give a bond, at the rate of $100 per mile of duct, before they are allowed to place their wires underground, and this must be done within six months of the time of making application. The sum of $1,000,000 has been appropriated for this work, to be raised by the issue of bonds.

THE ENGINEER BRIGADE, lately authorized by Congress, is making rapid progress in organization. The First Regiment is commanded by Col. Eugene Griffin, and is being recruited in New York and the Middle and New England States, and will be mobilized at Peekskill camp. The Second Regiment, commanded by Col. Willard Young, late of the Engineer Corps, U. S. A., is being recruited in Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa and West to California; his headquarters are at Fort Sheridan, near Chicago. The Third Regiment is being raised by Col. David D. Gaillard, of the Corps of Engineers, in Virginia and the South, to New Mexico; his headquarters are at Jefferson Barracks, near St. Louis. In the Second Regiment, Edward Burr, of the Engineer Corps, U. S. A., is Lieutenant-Colonel, and the three battalions will be commanded by Majors Richard H. Savage and Wm. C. Langfitt, of the Engineer Corps, U. S. A., and Major E. L. Pinckard, of Alabama. These three regiments will aggregate 3,500 men.

A NEW NAVAL ACADEMY, at Annapolis, Md., so long urged, is at last being considered by Congress. The present site of the academy was acquired in 1845, and has grown from 10 to 100 acres in area by later purchase. But the present buildings are unsightly, inconvenient and unsanitary; having been added to by patchwork methods as the needs became apparent. The plans for the new academy were drawn up some years ago, the estimated cost being $6,000,000. They include a complete sewerage system, since finished; and with the $1,000,000 appropriated last winter, an armory, boat house, cadets' quarters and a power-house are to be built. The building to follow are a new steam engineering department, academic building and library, a boiler house, department of chemistry and physics, and a chapel. The old buildings will all be torn down and the new structures will be systematically and handsomely grouped.

AMERICAN STEAMPSHIPS in the Atlantic and Gulf trade to the number of 42, have now been chartered by the government for the naval or army service. This number does not include those needed for service in the Pacific. As most of these vessels are chartered and not purchased, little effort is being made by shipping companies to replace them by new ships. Another reason for not building is that all the shipyards are now crowded by government work, and expect large contracts in the near future for new warships. The only new merchant steamships now being built on the Atlantic coast are two for the Old Dominion Steamship Co., at Chester, Pa. These are steel steamships of 2,017 tons each, 304 ft. long, 42 ft. beam and 27 ft. deep, costing from $400,000 to $500,000 each. The coastwise trade along the Atlantic coast is said to be flourishing, notwithstanding the withdrawal of vessels for government service.

THE COMPETITION for the building of railway stations in the city of Stockholm has been extended in time to Dec. 31, 1898, to accommodate American engineers who desire to submit plans in the competition. Mr. August Peterson, the Royal Swedish and Norwegian Vice-Consul, at Washington, D. C., forwards to us the terms and particulars of this competition, setting forth the scales to be used, general design, radii of curves and gradients, the prizes and manner of awarding, etc. These and the other details desired can be obtained by any engineer by addressing Vice-Consul Peterson at Washington.

A CONSOLIDATION OF SOUTHERN CAST-IRON PIPE foundries has been effected under the name of the American Pipe and Foundry Co., Chattanooga, Tenn. The new company has bought all the real estate, plant and equipment of the Howard Harrison Iron Co., Bessemer, Ala.; the Southern Pipe Co., Anniston, Ala.; the Chattanooga Foundry & Pipe Works, Chattanooga, Tenn., and the South Pittsburg Pipe Works, of South Pittsburg, Tenn. The officers of the new company are as follows: F. C. Miller, President; D. Giles, Vice-President; J. K. Dimmick, Second Vice-President and General Manager; E. B. Thomasson, Third Vice-President and General Sales Agent; M. Llewellyn, Treasurer; J. R. Kice, Secretary. We are indebted to Mr. Rich for the above information. We understand from other sources that this consolidation is the outcome of the recent U. S. Court decision against the "cast-iron pipe trust."

THE NEW YORK AND NEW JERSEY BRIDGE CO. held an annual stockholders' meeting on June 7. The report of Secretary Swan notes detail work performed on changes in plan; progress made upon perfecting a union contract with the New York and New Jersey Bridge Co. of New Jersey; and the location of an approach at 59th St., North River.

THE TRANSPORTATION OF A 64½-TON PLATE GIRDER BY RAIL.

The accompanying cut illustrates the manner of loading and shipping a plate girder 106 ft. long and 10 ft. deep, weighing 64½ tons, which was recently built by the Bridge and Construction Department of the Pennsylvania Steel Co., of Steelton, Pa., for the Grand Trunk Ry., Mr. Joseph Hobson, M. Am. Soc. C. E., Chief Engineer. This girder forms the center truss of a double-track railway bridge, and so far as we now recall is the heaviest single girder ever shipped complete by rail. As will be seen from the

SHIPMENT OF A 64½-TON PLATE GIRDER, 106 FT. LONG AND 10 FT. DEEP, FOR THE GRAND TRUNK RY.
Pennsylvania Steel Co., Steelton, Pa., Builders.

illustration, the girder is carried by two of the Pennsylvania R. R. Co.'s well-known steel gun cars, with an idle flat car acting as a spacer between them. In our issue of Sept. 12, 1895, we illustrated a similar method of shipping a girder 122 ft. 10½ ins. long and 9½ ft. deep, weighing 50 tons, and in our issue of April 15, 1897, we described the method of loading and shipping eight 95-ft. plate girders in pairs, each pair weighing 40 tons and being carried by three flat cars. Among other recent notable shipments of heavy single members by rail may be mentioned the 48½-ton end posts for the Bridesburg Bridge built by the Pennsylvania R. R. across the Delaware River at Philadelphia, Pa. (Eng. News, Oct. 31, 1895), and a 32½-ton riveted truss span 90 ft. long, with floor system and bracing complete, which was built for the Irondale, Bancroft & Ottawa Ry., in 1895 (Eng. News, June 13, 1895). It will be noticed that the girder which we illustrate here was considerably heavier than any of the others which have been mentioned. We are indebted to Mr. J. W. Rynders, Superintendent, Bridge and Construction Department, Pennsylvania Steel Co., for the photograph from which our illustration has been made.

80,000-LB. COAL CARS; ILLINOIS CENTRAL R. R.

(With double-page engraving.)

There is at the present time a marked tendency to increase the capacity of freight cars from 60,000 lbs., which has been practically the standard for several years, to 80,000 lbs., or even more under special conditions. This tendency we have discussed in another column, and in the present article we describe the new 80,000-lb. coal cars which have been put in service by the Illinois Central R. R. There are three special features of these cars to which attention may be called, as follows: (1) The relatively low dead weight to the high live load; (2) The increase in cubic capacity due to placing the side planking outside of the stakes; (3) The use of all-metal trucks.

These cars are of the flat-bottom, hopperless type, without doors in the sides, ends or bottom. Their floor framing is very substantial, consisting of eight longitudinal sills of long-leaf yellow pine, and two oak end sills, set 1¾ ins. higher than the other sills. This floor framing is strengthened by no less than eight truss rods, all of which pass through the end sills, six of them having large cast-iron washers on the sills, while the other two extend also through the deadwoods. These rods are all 1⅛-ins. diameter, with 1⅜-in. upset threaded ends. They are set up by open turnbuckles, a stick 1½ × 2½ ins., 7 ft. 6 ins. long being passed through all the turnbuckles to keep them from working loose. The stick itself is held in position by split keys passed through it. The 9-in. struts are 8 ft. apart, secured to the under side of oak needle beams, boxed out ½-in. for the sills, the truss depth from bottom of sill to top of truss rod being 18½ ins. The rods pass over iron saddles above the body bolsters. Each rod has its own separate strut and saddle, which parts are of malleable iron. The body bolsters are of iron, each composed of a horizontal top plate ¾ × 10 ins., and a bottom truss plate ⅞ × 10 ins., connected by rivets with malleable iron sleeves and spacers, and carrying side bearings of the same material. The depth of the bolster at the middle is about 8 ins., and at its ends the top plate is bent to form a pocket for the side sills. There are no end platforms, but on each end sill is an oak deadwood, 4 × 10 ins., secured by bolts, screws and the nuts of two of the truss rods. Over each needle beam, between the side and outer intermediate sills, are filler blocks 4 × 4 × 8½ ins.

There are twelve stakes on each side and two at each end. The stakes are of oak, 4 × 5 ins., but no regular stake pockets are used. Instead of this, each stake is held to the sill by a ½-in. carriage bolt at its lower end and a ¾-in. U-bolt (with grooved washer) passing through the upper part of the side sill. Some of the stakes near the center of the car are also held together by ¾-in. tie rods across the car, just above the sills, while four of the stakes are made of extra depth and secured to the ends of the needle beams by lag screws. The U-bolts for these latter stakes extend through the intermediate sills. The sides and ends of the car have four pine planks 2½ × 10 ins., the bottom planks being ½-in. clear above the floor. The planks are placed on the outside of the stakes, as already noted, which is a somewhat novel feature and increases the cubic capacity (Eng. News, Feb. 3, 1898). Each plank is secured to each stake by two ½-in. carriage bolts passing through an iron strap 3-16 × 2 × 40 ins., placed on the outside of the planking. No vertical tie rods or straps are used to fasten the sides down to the sills, and there is no iron strap upon the top of the sides or ends. The ends of the car are held by ¾-in. rods through the end side stakes; and the sides are also held together by two ¾-in. tie rods at each end. The corners are strengthened by heavy iron corner plates on the outside, through which pass the rods noted above. The floor is of transverse pine planks, 1¾ × 8 ins., rabbeted and spiked to the sills. The sides and ends of the car are flush with the outside faces of the sills, and the floor is flush with the top of the end sills, these being set 1¾ ins. higher than the longitudinal sills.

The trucks are designed on the most advanced principles of construction, their special features being the entire absence of wood, the use of metal bolsters, and the inside-hung brakes. The frames are of the modified diamond pattern, having the top bar nearly horizontal. The upper and lower arch bars are 1¼ × 4½ ins., and the tie bar is ½ × 4½ ins. The Haskell & Barker metal truck bolster is used, consisting of steel top and bottom plates ⅞ × 11 ins., and ⅝ × 11 ins., riveted to a cast steel filler or center piece. This bolster is 7 ft. 4½ ins. long, 12 11-16 ins. deep at the middle and 7⅜ ins. deep at the ends. Its ends pass through the frames and carry the column girders for the malleable iron columns. Each end rests on a nest of coiled springs seated upon the spring plank, which is an inverted 13-in. channel (34 lbs. per ft.), supported by the bottom bars of the diamond frames. The bolster carries a pressed steel center plate. The axles have journals 5 × 9 ins., with malleable iron boxes of the M. C. B. standard pattern.

The leading dimensions and particulars of these cars are given below in tabular form, and for purposes of comparison we have added similar particulars of the standard 60,000-lb. coal cars of the Lake Shore & Michigan Southern Ry., which are described and illustrated in our issue of March 19, 1896:

Dimensions of Coal Cars of 80,000 and 60,000 Lbs. Capacity.

	80,000 lbs., Illinois Central R. R.	60,000 lbs. Lake Shore & M. S. Ry.
Length over couplers*	38 ft. 6¼ ins.	34 ft. 0 ins.
" " end sills	36 " "	33 " 5½ "
" " inside body	35 " 7 "	.....
Width over stakes	9 " 4 "	8 ft. 6 ins.
" over side sills	8 " 6 "	8 " 0 "
" inside body	9 " 4 "	8 " 0 "
Height to top of sill	3 " 6¾ "	3 " 11¾ "
" to top of side	7 " 1¼ "	7 " 9⅝ "
" inside body	3 " 6½ "	3 " 6⅞ "
Center sills; pine	(2) 6 ×9 "	(2) 4½×8 "
Intermediate sills; pine	(4) 4½×9 "	(2) 4 ×8 "
Side sills; pine	(2) 5 ×12 "	(2) 5 ×12 "
End sills; oak	(2) 8 ×11¾ "	(2) 8 ×8 "
Needle beams; oak	(2) 4 ×10 "	(2) 4½×12 "
Truss rods	(8) 1⅛"	(4) 1¼"
Wheels, diameter	33 ins.	33 ins.
Trucks, center to center	26 ft. 0 ins.	24 ft. 0 ins.
Wheelbase, truck	5 " 2 "	5 " 0 "
" total	31 " 2 "	29 " 6 "
Journals	5×9 ins.	4¼×8 ins.
Cubic contents	1,176.4 cu. ft.	.....
Carrying capacity	80,000 lbs.	60,000 lbs.
Weight, empty	31,500 "	26,000 "
" loaded	111,500 "	86,000 "
Live load	71.75%	69.76%
Dead load	28.25%	30.24%

*Inside of knuckles.

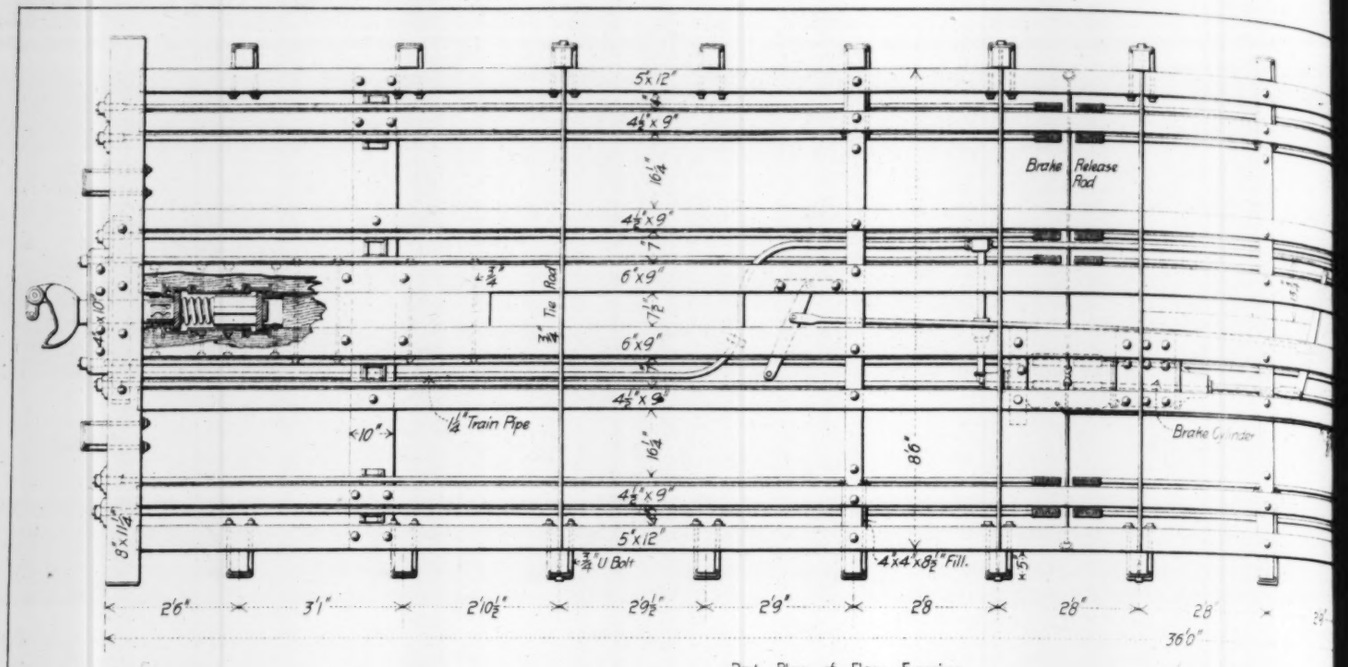
The Haskell & Barker Car Co., of Michigan City, Ind., recently built 500 of these cars, half of which were fitted with the "Lone Star" coupler and the others with the "Chicago" coupler, both of the M. C. B. type. The draft gear is between the center sills, the shank of the coupler passing through the end sill and deadwood, and behind the drawbar stops is a filler timber, 9 × 7½ ins., 3 ft. 9 ins. long, through-bolted to the center sills. All the cars are equipped with the Westinghouse air brake and pressure retaining valve, while the usual arrangement of brake shaft and hand wheel is also provided, a 12-in. end plank across the top of the car affording a foothold for the brakeman. The brakes are inside hung, with the shoes attached to metal brakebeams of the Williamson pattern, which are hung from malleable castings secured by the column bolts. There is also a full equipment of grab irons, steps and hand-holds as required by law.

The cars were designed in the mechanical department of the Illinois Central R. R., and for plans and other information we are indebted to Mr. W. Renshaw, Superintendent of Machinery, and Mr. W. H. V. Rosing, Mechanical Engineer, of this road.

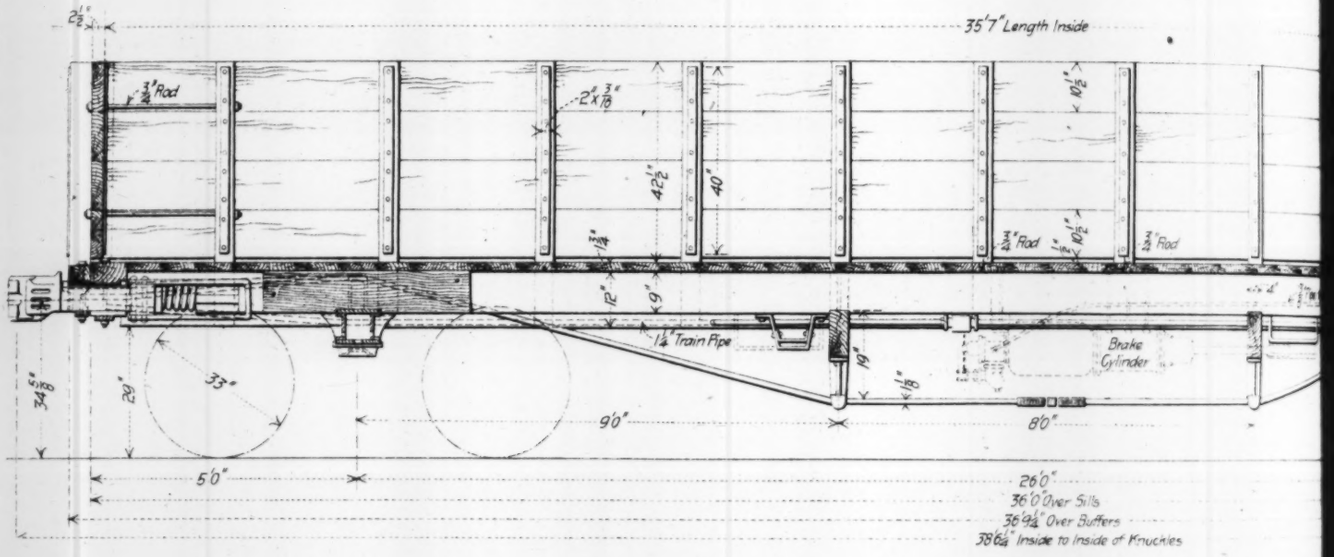
AN OLD EDGE RAIL, FROM THE EASTERN RAILWAY, OF MASSACHUSETTS AND NEW HAMPSHIRE.

We are indebted to the courtesy of Mr. Newell C. Trickey, Station Agent of the Boston & Maine R. R., at Lynn, Mass., for an interesting relic of early railway history in New England. This is a section of rail, and a chair used with it, which was found in the ruins of the Newburyport, Mass, railway station, lately destroyed by fire. Newburyport is on the line of the old Eastern Railway, which was opened to traffic, between Boston, Mass., and Portsmouth, N. H., on Nov. 9, 1840; and it is claimed that this relic was a piece of one of the rails first laid down on this road.

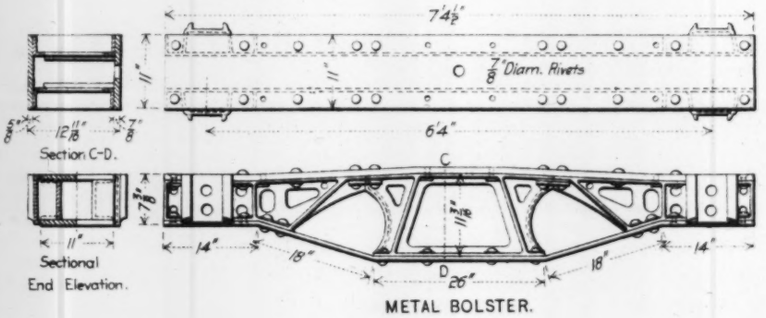
It is either cast, or malleable iron, and in section it closely resembles the edge-rail used on all but 18 miles of the old Philadelphia & Columbia Railway, completed in 1834. This Pennsylvania rail, as described by W. Hasell Wilson, Hon. Mem. Am. Soc. C. E., in his "Brief Review of Railroad History," was of the so-called Wigan pattern; cast in lengths of 18 ft.; with top and bottom surfaces parallel; weighing 41¼ lbs. per lin. yd.; and secured to iron chairs supported upon granite or sandstone blocks. The section before us agrees very closely with this weight, and the chair nearly conforms to that used on the Philadelphia and Columbia Ry. These old edge rails, says Mr. Wilson,



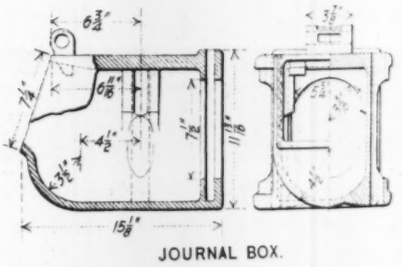
Part Plan of Floor Framing.



Sectional Side Elevation.



METAL BOLSTER.

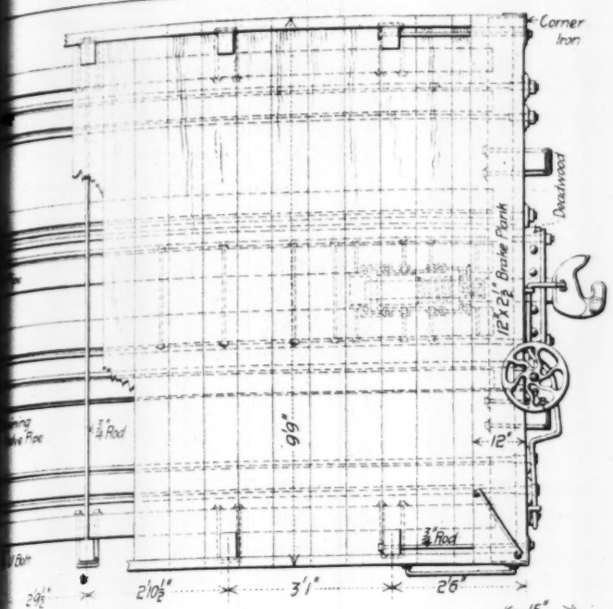


JOURNAL BOX.

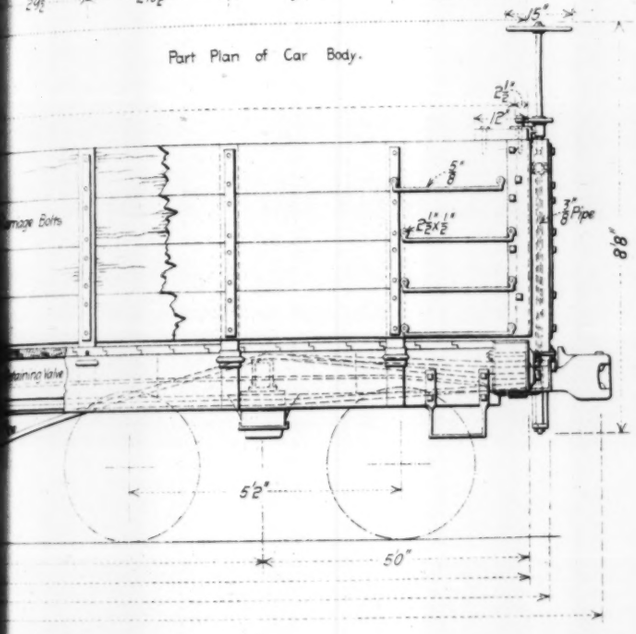
80,000-LB. COAL CAR; ILLINOIS CENTRAL R. R.

W. Renshaw, Superintendent of Machinery. W. H. V. Rosing, Mechanical Engineer.

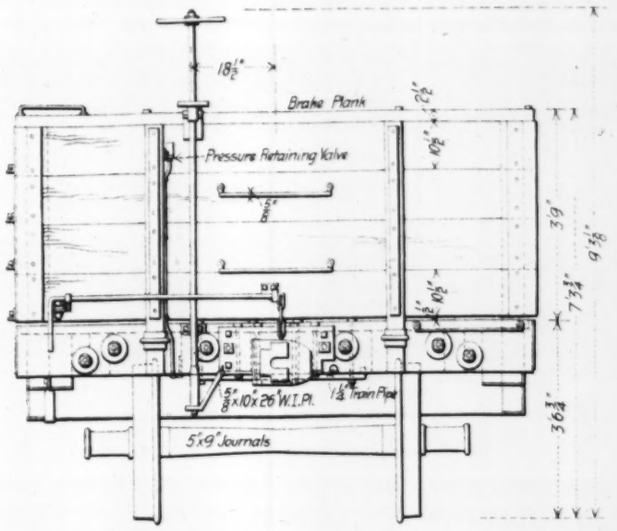
Haskell & Barker Car Co., Builders.



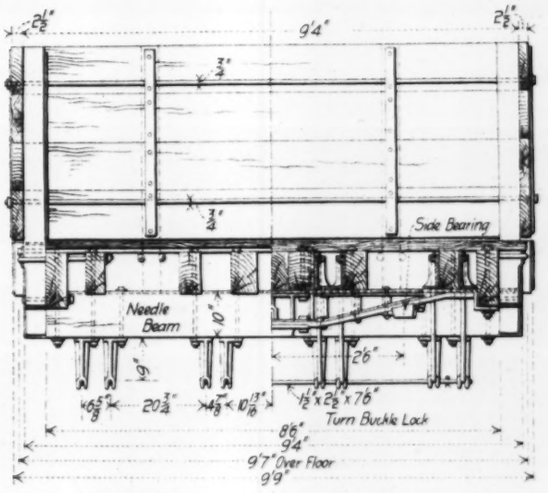
Part Plan of Car Body.



SECTIONAL ELEVATIONS OF CAR.

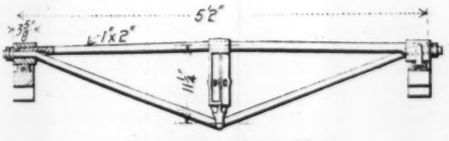


End Elevation.

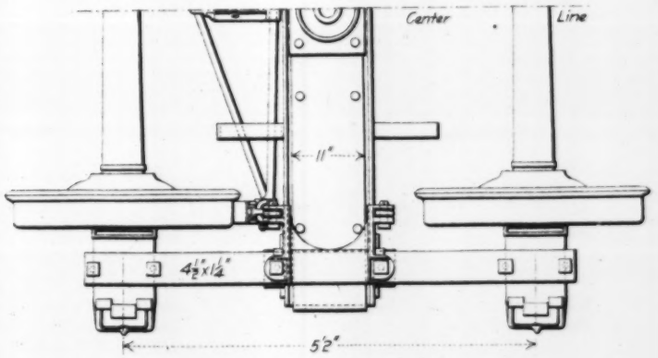


Half Section at Center.

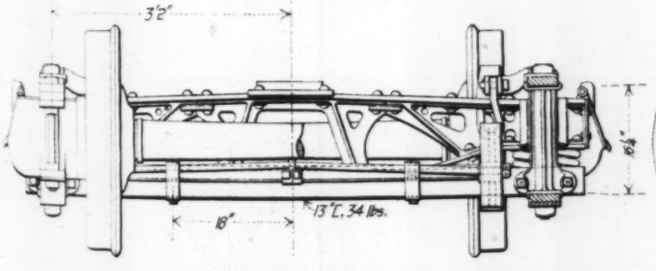
Half Section at Body Bolster.



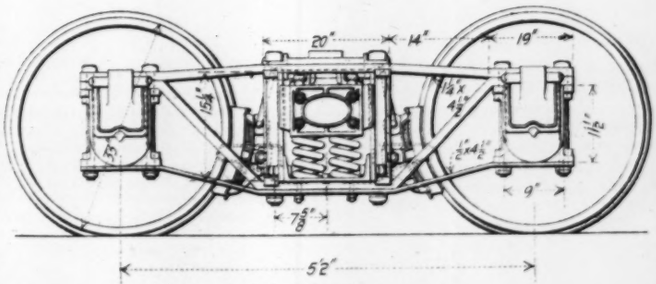
WILLIAMSON BRAKE BEAM.



Half Plan.



Sectional End Elevation.

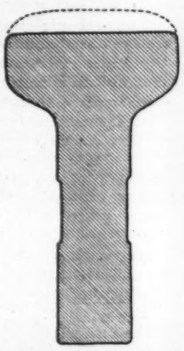


Side Elevation.

DETAILS OF TRUCK.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

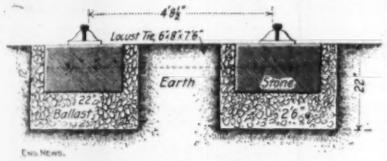
were made at the Ebbw Vale Works, in Wales, and they cost nearly $50 per ton, delivered at Philadelphia. The iron was of such excellent quality that when taken up, after many years' service, and replaced by T-rails, the old iron was rerolled into rods for bridge purposes. The rails were first ordered in lengths of 9 and 15 ft., the first to be used on curves; but experience soon taught these early engineers that the longer the rail the more easily could it be made to conform to the curvature of the road; and the length of the rail was increased to 18 ft. in all succeeding orders.



Section of Edge Rail Used on the Eastern Ry. of Massachusetts, 1840, one-half size.

(Dotted line shows probable original outline of Head of Rail.)

These rails were placed upon stone blocks, 22 × 16 ins., by 12 ins. deep, placed 3 ft. apart on centers, in the line of the track, and with a gage of 4 ft. 8½ ins. The blocks were placed in longitudinal trenches filled with broken stone; and at intervals of 9 ft. on curves and 15 ft. on straight line a locust cross-tie was substituted for the two stone blocks, to prevent the track from spreading. The rails were laid to break joint and the joint was made on the stone blocks next to the wooden sill. The joint used is not exactly certain; but old illustrations show a halved rail end, with a bolt going through both rails and the chair. On



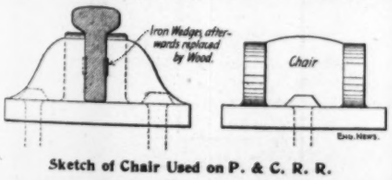
Cross-Section of Track Laid with Edge Rail on Stone Blocks and Locust Sills. Phila. & Columbia R. R.—1834.

the Philadelphia & Columbia Ry. the rail was secured to the intermediate chairs first by iron and then by wooden wedges; both gave great trouble by working loose, and men were constantly patrolling the road and tightening up these wedges with hammers. From the side-slot in the rail section here shown, it was probably intended for the iron wedge.

An "estimate for one mile" of the Philadelphia & Columbia Railway, as taken from the notebook of an old engineer by the writer, is interesting for its items and pr... We give this estimate, as follows:

64.8 tons	edge rails	at $44.50	$2,883.60
23.6 "	chairs	" 36.40	859.04
5.0 "	bolts and wedges	" 98.00	490.00
93.4 "	hauled	" 8.00	747.20
352 each	locust sills	" 1.80	633.60
2,816 "	stone blocks	" .90	2,534.40
2,000 cu. yds.	broken stone	" 1.25	2,500.00
1,760 days	labor	" .85	1,496.00
2,816 pieces	canvas	" .02	56.32
6 each	road and farm crsgs	" 13.00	78.00
1,800 cu. yds.	excavation	" .15	270.00
1,400 " "	embankment	" .20	280.00
	Total		$12,826.16

We omitted to mention that two holes were drilled into each stone block, and in these holes



Sketch of Chair Used on P. & C. R. R.

wooden pins were driven for holding the bolts which secured the chair to the block. The use of the "pieces of canvas" is not clear; but as there was one piece for each stone block, they were probably employed in connection with the joint between the chair and the block.

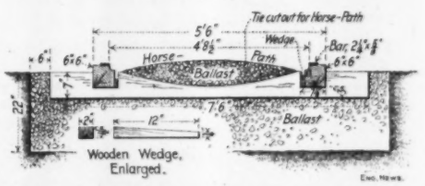
On the railway here referred to, and as taken from the same notebook, 18 miles were laid with wooden string-pieces, plated with flat iron bars, to expedite the opening of the road. In this construction chestnut or white oak cross ties, 7 × 7 ins. and 7½ ft. long, were laid 4 ft. apart on stone ballast. These ties were notched on the upper side, as shown, to take a yellow pine longitudinal, or rail, 6 ins. square. The rails were secured to the ties by yellow pine or white oak keys, 12 ins. long, 2 ins. high, and tapering from 1½ ins. to ¾-in. The flat iron bar nailed to the rail was 2¼ ins. wide by ⅝-in. thick, and the inside upper corner of the rail was champhered off to bring the bar more nearly over the center of the rail. The official estimate for "one mile" of this so-called wooden railway, was as follows:

23 tons	flat bars	at $41.00	$943.00
900 lbs.	spikes	" .10	90.00
710 each	splice plates	" .03½	24.85
	hauling iron		96.00
37 M.ft.B.M.	scantling, 6x6 ins.	" 20.00	1,073.00
1,320 each	sills	" .50	660.00
320 rods	laid	" 2.26	723.20
320 "	horse path	" .50	160.00
	removing earth		301.00
	extra work		32.68
1,334 perches	broken stone	" 1.12½	1,500.75
	Total		$5,604.48

In this connection it is of interest to note that the late J. Dutton Steele, in a paper upon "The Early History of Railways and the Origin of Gage," read before the American Society of Civil Engineers in 1872, ascribes the origin of the word "tram," as applied to rails, to one Benjamin Ostram, who, in 1800, substituted stone blocks for wooden sills in supporting the rails. Mr. Steele says that the new type of road was first called the Ostramway, and then, by contraction—tramway. This derivation, however, is not upheld by later research. The Century Dictionary derives "tram" from the old Saxon tram or trum, a log, or stock of a tree; and the English word, in the sense of a rail, seems to have first been applied to a rail or plank in a tram road or plank road; then to lines of rails or planks, and finally to the road itself. As applied to a car in mines, the word may come from the Swedish word "tram," meaning a kind of sled. In any event, as applied to a road the word long antedates Mr. Ostram; for, in the will of Ambrose Middleton, dated Aug. 4, 1555, the following bequest occurs: "To amendinge of the highwaye or tram, frome the weste ende of Bridgegait, in Barnard Castle, 20s."

SPECIFICATIONS FOR MOTORS USED ON THE CENTRAL UNDERGROUND RAILWAY OF LONDON.

(The following letter, received from Mr. E. D. Priest, of the railway department of the General Electric Co., Schenectady, N. Y., was sent in response to our request for further details of the electric locomotives to be used on the London Cen-



Cross-Section of Track Laid with Strap Rail on Wooden Sills. P. & C. R. R.—1834.

tral Underground Ry., of which an illustration and general description was given in our issue of June 9, 1898.—Ed.)

Sir: This motor, known as the G E—56, will be of the 500-volt direct current, four-pole, enclosed type. It is gearless, the armature being mounted directly on the car axle and the frame supported from the truck on suspension bars, is designed for heavy hauling work and will fulfil the following detail specifications:

Magnet Frame.—The general shape of the frame will be that of an oblong box with the edges and corners rounded. It will be made of cast steel of high magnetic permeability cast in two halved with the split along a plane passing through the axis of the armature and inclined at an angle of about 25° from the horizontal. These halves will be held together by three hinge bolts on one side of the frame and three standard bolts on the other side, thus permitting the lower half to be swung down, exposing the armature for inspection or cleaning. There will be a large opening in the top frame just over the commutator through which the commutator and the brush holders may be inspected and worn out brushes replaced. Through this opening it will be possible to remove the brush holders and the supporting studs and brackets. This opening will be protected by a quickly removable malleable iron cover, which will be securely clamped down by an adjustable cam-locking device. In the bottom frame directly under the commutator there will be a large handhole protected by a cover. The armature being mounted directly on the axle and the frame supported by suspension bars from the truck, there will be no bearings on the motor. At the ends of the frame there will be about 5-16-in. clearance between the latter and the axle, and a felt protector will be fitted into this opening to exclude dust and grease.

Armature.—The armature will be of the iron clad type. The laminae will be insulated from each other with coats of japan. The slots in the laminae will be punched uniformly so that the assembled core will have smooth and regular slots in which to place the armature conductors. The armature will have a series drum-barrel winding. The insulation will consist of mica and of specially prepared tape and cloth, which has high insulating qualities and is practically impervious to moisture. Each of the 61 core slots will be wide enough to accommodate a set of three conductors. The conductors will be soldered directly into ears forming a part of the commutator segments, thus avoiding entirely the use of connecting leads. To prevent carbon dust from getting into the end windings, they will be thoroughly covered by canvas securely bound in place. The conductors will be held in the slots by suitable tinned steel wire bands, the wires being soldered together and securely held by tin clips.

Commutator.—The commutator will have 183 segments built up and securely clamped on a malleable iron shell, using the best quality of mica for insulation. The diameter of the commutator will be 19 ins., the total length of the segment 9⅝ ins., the wearing length 8⅛ ins., and the minimum wearing depth 1 in. at the front end. The cone clamping insulations will be of the best quality of mica, built up and pressed hard and compact. The mica between the segments will be of a somewhat softer quality so that in service it will wear down evenly with the copper segments. Segments will be of the best hard drawn copper. The commutator will withstand without injury a high potential test of 5,000 volts between the segments and the shell and 500 volts between the adjacent segments and will run without sparking.

Field Coils.—There will be four field coils, two sides and top and bottom coils, wound on metal spools, the latter to be held in place by easily removable laminated pole pieces, which are bolted to the frame by through bolts with nuts on the outside. The side field coils will be much thicker than the top and bottom ones, and all will be wound with strip copper of ample cross section, the winding to be thoroughly insulated from the spool. The field coils will withstand without injury a high potential test of 5,000 volts between the windings and the metal spools.

Leads.—All leads will be brought out through rubber-bushed poles in the magnet frame in such a way as to be easily removable and it will not be necessary to disconnect any leads inside the magnet frame when it is desired to swing the lower frame down for inspection.

Brush Holders.—The brush holders will be made of cast brass and have four carbon brushes per holder. Brushes will slide in finished ways and be pressed against the commutator by independent fingers which will give a practical uniform pressure throughout the working range of the brushes.

Capacity and Weight.—This motor will have a capacity of about 200 HP. and the efficiency will be about 92.8% maximum.

(Slight changes in original plans have been made, but the following figures are final.—Ed.)

Drawbar pull of complete locomotive, at start 13,500 lbs., at full speed (30 miles per hour) 3,600 lbs.; maximum speed 30 miles per hour, average speed 14.7 with 20 sec. stops, 17.8 not including stops; torque of each motor at starting 3,375 lbs., with 42-in. wheels; motor, revolutions per minute, at average speed 117 or 141, weight of armature 3,000 lbs., of field 9,000 lbs., of complete motor 12,000 lbs.; controller, type K 19, general dimensions 28⅝ × 39¼ ins., over all height 47⅛ ins., height above floor 33¾ ins.; current required by locomotive at starting 1,160 amperes.

Very truly yours,
E. D. Priest,
Railway Eng. Dept.

Schenectady, N. Y., June 10, 1898.

ELECTRIC HEADLIGHTS FOR LOCOMOTIVES.

The big headlight which has for so many years been one of the prominent features of the equipment of American locomotives is undergoing some modifications in its form and in the character of its light. The huge rectangular box lantern is gradually giving place to a smaller and more compact lantern of circular shape, and the oil lamp is to some extent being superseded by the electric light. The general introduction of the electric light for streets and buildings has been accompanied by the application of this light to

various special purposes, and within the past ten or twelve years several attempts have been made to apply it to locomotive headlights. Experimental plants of different kinds have been devised and tried, but the earlier ones were too heavy and cumbersome and too unreliable for practical service. Great difficulties were encountered in obtaining dynamos and steam engines which should combine smallness and compactness with economy, durability and reliability in service under the severe conditions under which they work, owing to the constant jarring and vibration of the locomotive itself, which forms the foundation for the lighting plant. The experiments have been followed up, however, with the result that a lighting plant has been perfected which appears to meet all the requirements noted above, and whose practical value is shown by the fact that since its introduction, about 2½ years ago, it has been applied to more than 200 locomotives.

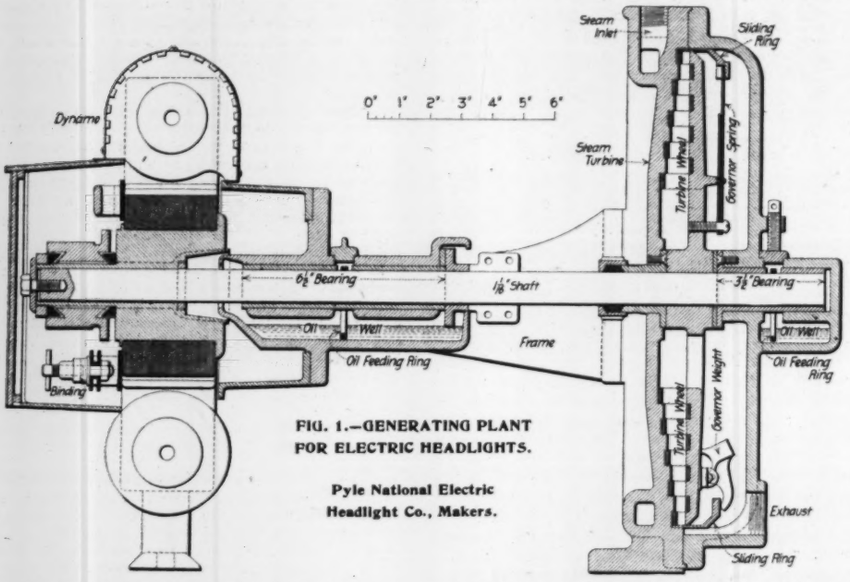


FIG. 1.—GENERATING PLANT FOR ELECTRIC HEADLIGHTS.

Pyle National Electric Headlight Co., Makers.

The great advantages of the electric headlights are in the direction of preventing accidents and assuring additional safety at night to trains, passengers and persons on the track. The brilliant and far-reaching beams of light give a sharp and unmistakable warning to the enginemen of trains running in opposite directions on single track; they enable the enginemen to distinguish cars, animals, fallen trees or other obstructions on the track; and they give an effectual warning of the approach of a train to persons on the track and at grade crossings. These three classes of warnings are given at such a distance ahead of the train as to make them a very practical safeguard. The direct light can be seen at a great distance, and its reflection in the sky or on the clouds at an even greater distance, even as much as 10 miles in level country, and 3 or 4 miles in rough country. The light reflected in the sky and upon hillsides, etc., cannot but attract the attention of an engineman, and on single track lines with many curves such headlights are a very good preventative of head or rear collisions. With this light on his engine, an engineman can see obstructions half a mile away, and reports from the officers of railways using the electric headlight mention a number of cases where animals, cars and other obstructions on the open track have been seen in time to stop the train, and, perhaps, prevent serious accidents. For such a purpose, or for warning people at grade crossings, the ordinary headlight with its oil lamp is practically useless, and it is urged, with some reason, that the electric headlight may be classed as a safety appliance, as well as the air brake and the automatic coupler.

An objection which is sometimes urged against the electric headlight is that the intense white light will tend to obscure the light from tail lamps and switch and signal lamps, making it difficult to distinguish these lamps or their colors at as great a distance as when the electric light is not used. This would be a somewhat serious objection if founded on fact, but experiments, as well as experience in service, show that the electric light has no such effect. In a test made on the Cleveland, Cincinnati, Chicago & St. Louis Ry., with an engine having an electric headlight, men with red, white and green lamps were distributed along the track and instructed to wave their lamps across the track and also to hold them at the side of the track as the engine approached. Runs were made at various rates of speed, and these lights, as well as switch lights, were carefully noted by observers in the cab. It was found that red lights showed even more distinctly in the beam of the electric light, and that there was no diminution in the brilliancy of green or white lights, nor in the distance at which the lights could be distinguished. Another objection made is that on double track the lights will dazzle the eyes of the enginemen on passing trains, but as the beam is directed straight ahead such an effect could only be produced momentarily on a curve, the tracks being too far apart for it to be produced on a tangent. No trouble of this kind has been experienced on railways using the electric headlight. The cost of the installation is also sometimes put forward as an objection, this being considerably more than the cost of an ordinary headlight, but against this must be set the increased safety in operation. The cost of maintenance is slight.

In the system already referred to as being now in somewhat extensive use, the generating plant consists of a Pyle steam turbine and a Pyle dynamo mounted on opposite ends of a horizontal shaft 1 1-16 ins. diameter. This plant, shown in Fig. 1, is mounted on the smokebox, behind the lantern, with the shaft at right angles to the center line of the engine. It is 26 ins. long, 18 ins. high and 18 ins. wide. Its weight is only 250 lbs., of which the revolving parts (turbine wheel, shaft and armature), represent but 42 lbs. A ¾-in. steam pipe is led from a valve in the cab to the wheel-case, and is connected to one or other of three tapped openings, as may be most convenient, the other openings being plugged. The steam enters the wheel chamber through four small ports, and (at a pressure about 25 lbs. below the boiler pressure) is directed against the rim of the 15-in. wheel, which has five concentric rings of buckets, upon each of which the steam must impinge before it escapes at the center of the wheel and passes into the exhaust chamber. From this chamber a 1¼-in. exhaust pipe is led into the smokebox or smokestack. The shaft is supported by an end bearing 3⅛ ins. long, outside the wheel case, and by a bearing 6½ ins. long close to the armature. The bearings are of phosphor bronze, and are kept lubricated by loose rings on the shaft, the lower ends of these rings running in oil wells. The normal speed is 1,800 revolutions per minute, with a variation of only 15 or 20 revolutions between full load and no load, and the turbine develops about 1 HP. at normal speed. The speed is controlled by four governor springs whose tension can be adjusted by a tap screw at one end. On the back of the wheel are four hinged weights, so formed that as the weighted end flies out (as the speed increases), the finger end moves inward, forcing in a sliding ring and thus closing the steam ports. The springs tend to draw this ring back and so open the ports. The dynamo generates a current of 25 amperes at 40 volts. Its armature is attached to the shaft by a single screw at the end, which can readily be removed. A graphite brush is used at the top and a carbon brush at the bottom. The brush holders are fixed, and the brushes can be removed and changed without changing the tension of the springs. The dynamo supplies current for incandescent gage lamps in the cab as well as for the arc headlight, which is of about 4,000 c. p.

The lamp, Fig. 2, is of simple construction, designed specially to give a steady and unbroken light in spite of the constant jarring and jolting of the engine. No wheels or gears enter into its construction. The lower carbon is held up by a double coiled spring, its upper part having a guide with fingers which engage with a guide on the upper carbon and so keep the carbons centered to maintain the arc. The upper carbon is held by a clutch near its lower end, and bears against an upper guide which holds it vertical. This carbon can be burned till it is only 2 ins. long. The clutch is a ring slightly larger than the carbon, so that the latter is held when the ring is inclined, but can slip when it is on a horizontal plane. This clutch ring is attached by a wire to one end of a lever, the other end of which carries the iron armature or plunger of a solenoid magnet. The tension spring pulling down on this lever keeps the carbons in contact at the beginning, this being necessary in order to complete the circuit when the current is turned on. When the current, passing through the solenoid magnet becomes of sufficient power, the magnet draws down the armature or plunger, thus pulling down the end of the lever and separating the carbons so as to form the arc. The magnet and spring acting in opposition maintain the lever in proper balance and keep the arc uniform. The position of the arc can be adjusted

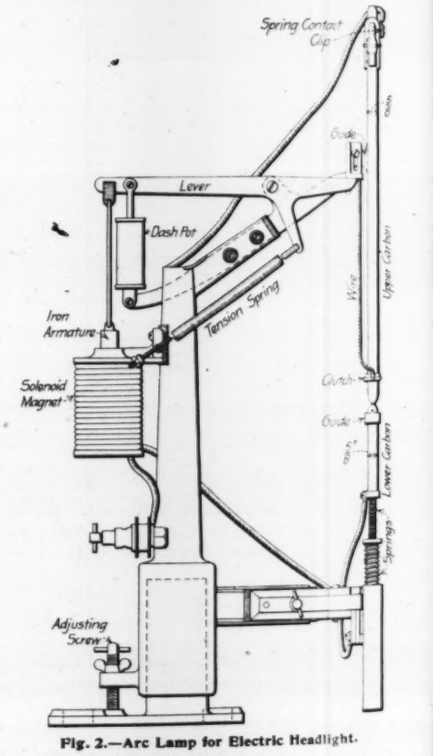
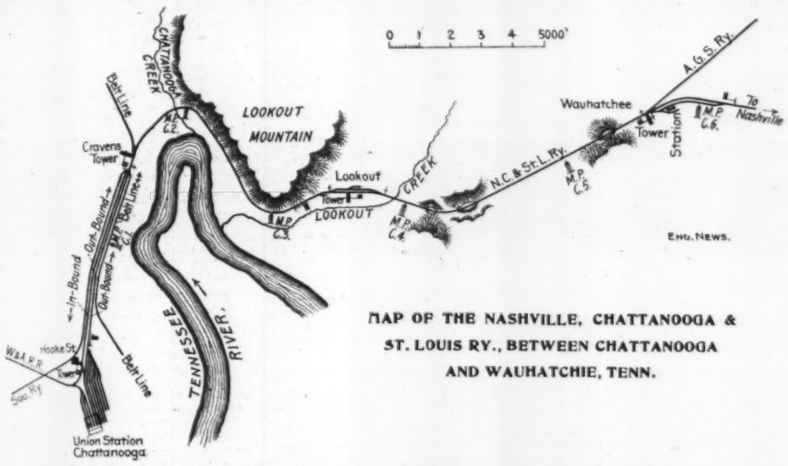


Fig. 2.—Arc Lamp for Electric Headlight.

vertically by the thumb nut on the adjusting screw at the base of the supporting pillar.

The apparatus above described was designed by Mr. George C. Pyle, who is the electrician of the Pyle National Electric Headlight Co., Monadnock Block, Chicago; President, Royal C. Vilas; Sales Agent, Mark A. Ross. The first light was put in service in August, 1895, and the equipment has already been applied to over 200 locomotives on a number of roads, some of these roads having it on 25 or 30 engines, while others are using it on a few for experimental purposes. The light and the apparatus have proved very successful in point of efficiency, cost of maintenance, and the prevention of accidents, and the company has a large number of orders on hand from railways which have had satisfactory experience with the headlight.



MAP OF THE NASHVILLE, CHATTANOOGA & ST. LOUIS RY., BETWEEN CHATTANOOGA AND WAUHATCHIE, TENN.

A MACHINE FOR LOADING BOX CARS.

We are indebted to Mr. Herman D. Ruhm, of Mt. Pleasant, Tenn., an engineer and manufacturers' agent in the phosphate land and rock business, for a description and drawing of an ingenious and successful machine for loading crushed phosphate rock into box cars. The machine was designed and built by Mr. Wm. W. Praytor, Superintendent of the Tennessee Phosphate Co., Mt. Pleasant, Tenn. It is covered by U. S. Patent No. 600,448, dated March 8, 1898. Mr. Ruhm's description is as follows:

As all phosphate rock must be protected from wet weather it must be loaded in box cars, and the practice generally has been where loading is done from chutes, either direct from crusher, from the screen, or from storage bins, to have from two to four men in the car shoveling the rock into the back ends. With the Mount Pleasant rock there is such an enormous amount of dust that men could not possibly stand working under the chutes in the cars more than 30 minutes at a time. Mr. Praytor was forced to work two shifts of four men each, 30 minutes to a shift, and had to pay them full time. The best these eight men could possibly do was to load eight cars in ten hours, or a labor cost of $1 per car. The consequence was that the company found difficulty in getting away a sufficient number of cars, and had to load from storage sheds and at night.

Mr. Praytor set to work to overcome the difficulty and succeeded admirably. He designed the first wheel or loader some time in the early part of June, 1897, and though it was somewhat crude in construction, it performed the work so well that he applied for a patent on it, which was granted March 8, 1898.

The principal features of the design are as follows: Mounted on a horizontal shaft is a wooden drum reinforced at each end with circular disks of sheet iron having in the space between the protruding faces of the discs nine vanes or paddles, hinged on the wooden drum, and equally spaced 40° apart. The motion of the outer ends of the vanes is limited to a 4-in. swing by small stops riveted on the inside faces of the disks, so that when the wheel is revolving in one direction the vanes slant in the reverse direction, and vice versa, the change of position taking place by centrifugal force alone. The wheel is shown in the drawing at A, and the movable chute B, supported in position by the braces C, feeds the rock on to the wheel. In the position shown in the drawing, the wheel is drawn out of the car, in which position it remains while moving the car in front of it. When ready to load a car the wheel is shoved into the car, the pulleys F and G moving up next to D and E, making all four of them opposite their respective similar pulleys, D^1, E^1, F^1, and G^1, on the line shaft. All the pulleys on the line shaft are tight and there are two belts, one crossed and one direct. Pulleys D, E and G are loose, while F is tight. Then the movable bearing H is placed under the shaft close to the drum, resting on the floor of the car, and the top of the bearing is clamped on as indicated. The chute gate is opened and the first belt slid onto the pulley F, which, of course, causes the drum to rotate, and the rock dropping on it is struck by the vanes and thrown back in the car. As soon as one end is loaded, the first belt is slipped onto the loose pulley G, and the second belt onto the tight pulley, reversing the direction of motion and thereby reversing the position of the vanes and throwing the rock into the other end of the car.

With this device there is no trouble in loading from 15 to 20 cars per day, if necessary. With a crusher already in operation, practically no extra power is required for this machine. The saving with an average output of 8 to 10 cars per day is at least $150 to $200 per month.

It is especially adapted to phosphate loading, but can be used for loading any material transported in box cars, and to be loaded from the end of a chute, such as pyrites, grain, etc.

Actual experience has demonstrated the proper speed to be about 225 revolutions per minute for 3-in. product, and 300 for 1-in. product.

The Tennessee Phosphate Co. has already saved in less than a year's operation considerably over $1,500 in labor, by the use of this device.

Mr. Praytor is preparing to have the machine manufactured for sale to other parties in the field.

OPERATION OF THE BLOCK SYSTEM AT CHATTANOOGA, TENN.; N., C. & ST. L. RY.

The heavy traffic on the Chattanooga terminal line of the Nashville, Chattanooga & St. Louis Ry. has been operated by the block system for several years, as shown by the record given below. This line extends from the union station at Chattanooga to the junction at Wauhatchie, 6 miles, as shown on the accompanying plan. From the city to the Belt Line Junction at Cravens, 1.6 miles, there are three tracks, two for northbound and one for southbound traffic. From Cravens to Wauhatchie there is a single track, 4.4 miles long. The line is used not only by the N., C. & St. L. Ry. but also by the trains of the Alabama Great Southern Ry. and of the Memphis Division of the Southern Ry.

There are signal towers at Wauhatchie, Lookout, Cravens and Hooke St., Chattanooga, the train dispatchers being in the latter tower and directing the operators what signals to show and what trains to pass. The switches marked X are operated from the signal towers. The trains are governed entirely by the signals, no train orders being given. When a passenger train is on the block between Lookout and Cravens, no other train is allowed on the block, and the entire length of six miles is worked on the absolute block system during bad weather. Of the total number of trains passing over this track, 22% are handled under caution signals. It will be seen by the statement given below that during the 9½ years ending with Dec. 31, 1897, there were 178,232 trains handled on this single track line, the average traffic being 54 trains per day, with a maximum of 85 trains per day. Yet we are informed that the total cost on account of accidents up to the present time has been 65 cts., a fact which speaks volumes for the safety and efficiency of this system of operation.

For the tabular statement given herewith, and for the plan of the line, we are indebted to Mr. J. W. Thomas, Jr., Assistant General Manager of the Nashville, Chattanooga & St. Louis Ry.

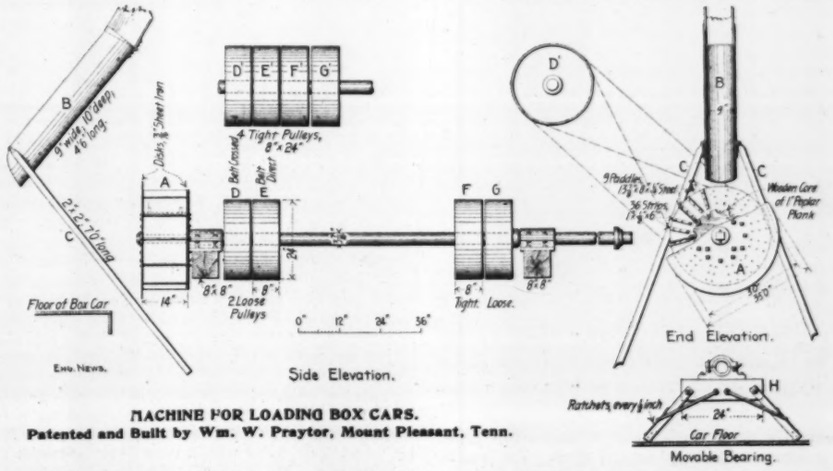
Number of Trains Handled by Block System Between Chattanooga and Wauhatchie, in 9½ Years.

	Single track.			Double track.		
Year ending June 30.	Total trains.	Ave. per day.	Max. in any day.	Total trains.	Ave. per day.	Max. in any day.
1889.....	18,160	49.7	67	18,549	70.8	76
1890.....	18,803	51.5	77	24,341	66.6	90
1891.....	21,429	58.7	85	25,275	69.2	102
1892.....	20,339	55.7	83	21,381	58.5	91
1893.....	19,608	53.7	72	23,023	63.0	93
1894.....	17,848	48.8	64	21,234	58.1	87
1895.....	17,029	46.6	70	20,628	56.9	83
1896.....	17,621	48.0	64	22,153	60.0	109
1897.....	17,920	49.1	70	21,090	57.7	77
1897*.....	9,485	51.5	66	10,795	58.5	73
9½ years...	178,232	54.0	85	208,379	63.0	109
Ave. per yr.	18,761	..	..	21,934	..	..

*Six months ending Dec. 31, 1897.

TEN-WHEEL PASSENGER LOCOMOTIVE; SOUTHERN RY.

Within the past few years there has been a very marked increase in the weight and size of American locomotives, and this is characteristic of railway practice in general and not of a few lines only. In our issue of April 14 we noted that two of the heaviest locomotives ever built had been added to the equipment of the Great Northern Ry., and in the present article we describe some of the heaviest, if not the heaviest, locomotives ever built for express passenger service. These engines, two in number, were built for the Southern Ry.



MACHINE FOR LOADING BOX CARS.
Patented and Built by Wm. W. Praytor, Mount Pleasant, Tenn.

by the Richmond Locomotive Works, of Richmond, Va., from designs prepared by Mr. W. H. Thomas, Superintendent of Motive Power of the road. The engines are of the ten-wheel type, with cylinders 21×28 ins., and driving wheels 6 ft. diameter. The general view, Fig. 1, shows that the

engines have a handsome and powerful appearance. They are intended specially for hauling the fast and heavy "Southwestern Limited Express," and are designed to maintain a good speed on the heavy grades and difficult parts of the line rather than to attain exceptionally high speed on the easier portions. On the mountain divisions there are grades of 1.33 to 1.55%, some of these being from two to four miles long, and having

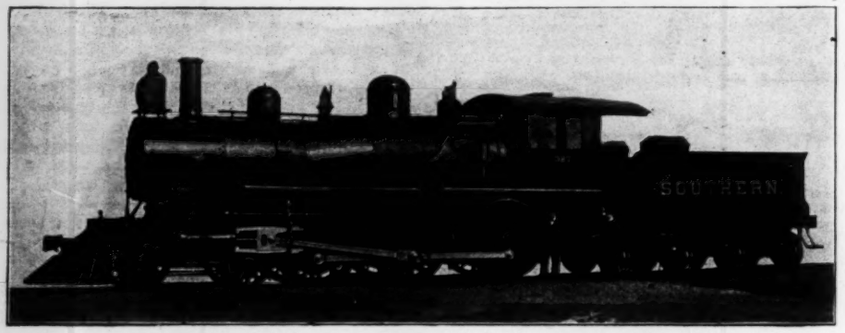


FIG. 1.—TEN-WHEEL PASSENGER LOCOMOTIVE; SOUTHERN RAILWAY.
Richmond Locomotive Works, Richmond, Va., Builders.

curves of 3° to 6°. The gage of the track is 4 ft. 9 ins.

The Washington & Southwestern Limited express is a through train from Washington to New Orleans, and consists normally of 11 cars: 7 sleepers, 1 day car, 1 baggage car and 2 mail cars. A dining car is also attached for certain portions of the run. The new engines are run on the division between Washington and Charlottesville, 380 miles, the schedule time being 10 hours and 42 minutes southbound, and 10 hours and 12 minutes northbound. This gives an average speed of about 35 miles per hour southbound and 37 miles per hour northbound, from start to finish. When allowances are made for 8 stops, for the delays incidental to single track running, and for the fact that the run of seven miles from Washington to Alexandria takes 20 minutes (on account of the Long Bridge and the grade crossings), it will be seen that considerably higher speeds must be maintained between the stops. The heaviest grades occur between Charlottesville and Danville, 126 miles. For this distance the train is allowed 3 hours 33 minutes southbound (with three stops), and 3 hours 25 minutes northbound (with one stop), giving an average speed of about 36 miles per hour. The engines may also be used on the lighter and faster Florida Limited express, which is composed of six cars (compartment, drawing room, observation, sleeper, dining, and combination day and baggage car), and makes the run of 380 miles in 9 hours, 51 minutes, or at the average rate of nearly 40 miles per hour.

We have compiled the following table, giving a comparison of these engines with some other heavy engines of the same type built for a similar class of service, and it will be noted that while the total weight is slightly in excess of the next heaviest engine, the weight on the driving wheels is less than in the A., T. & S. F. Ry. engines described in our issue of March 3.

Railway.	Builder.	Cylinders, ins.	Diameter of driv'g wheels.	—Weight, lbs.— On driving wheels.	Total.
Southern	Richmond.	21 × 28	72 ins.	121,250	158,000
A., T. & S. F.	Dickson.	19½ × 28	73 "	125,300	156,800
Nor. Pac	Schenectady.	22 & 34 × 26	69 "	112,000	155,000
	Baldwin.	20 × 26	63 "	117,800	150,000
Sav., F. & W	Rogers.	20 × 24	72 "	110,000	150,000
Balt. & Ohio.	Baldwin.	21 × 26	78 "	112,800	146,400
Ches. & Ohio.	Richmond.	20 & 32 × 24	62 "	115,000	145,000
Ill. Cent.	Rogers.	19½ × 26	69 "	109,000	144,500
Pennsylvania.	Schenectady	20 & 30 × 24	74 "	106,000	143,000

The boiler is of the extended wagon-top type, with a single cylindrical barrel ring. The sandbox is mounted on this part of the barrel, the bell is on the throat sheet, and the dome is on the front end of the wagon-top. Owing to the height of the boiler and dome, the whistles and safety valves are mounted on a separate boiler fitting behind the dome. This is a vase or wine-glass shaped casting, with a flanged base held by some of the radial stays, while others of the firebox crownstays have flattened ends secured to the inside of the stem of the casting by tap bolts. The 7½-in. opening in the boiler shell is reinforced by a heavy ring on the inside. Pipes outside the boiler jacket lead from the stem of this fitting to the dome and the cab. The dome has a cylindrical steel shell, riveted to a top casting and a flanged base ring which is riveted to the boiler, the 32¾-in. opening in the boiler shell being strengthened by ⅝-in. plates on the inside. The construction and fastenings of the dome are shown in Fig. 2. The throttle valve is of the railway company's standard pattern. The firebox is long and wide, the width over all at the bottom being 4 ft. 2 ins. The crown sheet has a radius of 6 ft. 8¼ ins. and is supported by radial stays from the roof of the wagon-top, whose radius is 2 ft. 11 5-16 ins. The crown sheet slopes downward from the tube plate to the back plate. Drilled staybolts are used, 1⅛ ins. in diameter, each having a 3-16-in. hole drilled 1 in. deep from the outside. The total length of firebox is 10 ft. 9½ ins., out to out of water spaces, and the bottom is horizontal for 5 ft. 1 9-16 ins,. thence dropping 11¼ ins. to the front end. There are 295 tubes of charcoal iron, 2 ins. outside diameter, the rear ends of which are swaged and fitted with ferrules of No. 16 copper, while the front ends have ferrules of No. 22 copper. The engines use bituminous coal for fuel.

The top member of the frame is inclined downward between the rear and main driving axles to carry the sloping bottom of the firebox, the front of the firebox butting against a vertical offset in the frame. The cylinder saddles are double bolted to the smokebox, the bottom of which is reinforced by a ⅝-in. steel plate on the inside. The crossheads are of cast-steel, tinned on all bearing surfaces, and the piston rods have a taper fit and are secured by jam nuts, thus dispensing with keys and key slots. The rods are of steel, of I-section, and the side rods have solid ends, while the big end of the connecting rod has a strap secured by three bolts. The driving springs are all hung under the driving boxes, and connected by equalizers suspended below the bottom member of the frame. Each spring is attached by a pin through its strap to the center of a cross piece held by two 1¼-in. bolts which pass down through the driving box.

The valve gear presents some novel features, as will be seen from the details in Fig. 3. It is designed to avoid the objections to the long eccentric rods generally used in this type of engine (which rods are bent to clear the axle next to the driving axle), and also to avoid the objections to an arrangement of gear having an intermediate or motion bar to clear the forward axle and using very short valve rods. It will be seen that in these engines the valve gear is entirely between the forward and main driving axles, the rocker being operated by means of a return bar. This involves the use of a very long valve rod, and the rod is supported by a bushed bearing in the guide yoke, as shown in the general view, Fig. 1.

The general dimensions of the engines are as follows:

Dimensions of Ten-Wheel Passenger Locomotive; Southern Ry.

Running Gear:	
Driving wheels (6), diameter	6 ft.
Truck wheels (4), diameter	3 "
Tender wheels (8), diameter	3 ft. 2 ins.
Driving wheel centers	Cast-steel.
Truck and tender wheels	McKee & Fisher steel-tired.
How are driving-wheels tires secured?	By shrinkage.
Engine truck	Swing center.
Journals, driving axles	8½ × 11 ins.
" truck axles	5½ × 10 "
" tender axles	4½ × 8 "
Wheelbase.—Driving 14 ft. 7 ins.; truck	6 ft. 9 "
Total engine	26 " 1 "
Tender	17 ft. 3 ins.; engine and tender 49 " 11½ "
Truck-pin to center leading driving wheel	8 " 1½ "
Wheels having blind tires	Middle drivers.
Weight in Working Order:	
On driving wheels, 121,250 lbs.; on truck wheels 36,750 lbs.	
Engine total	158,000 "
Tender, empty....35,000 lbs.; loaded	87,500 "
Water in tank....37,500 " ; water in boiler, 2,000 "	
Coal on tender	15,000 "
Does countrbince. conform to M. M. Assoc. rules?	Yes.
Weight of piston....318 lbs.; piston rod	170 lbs.
W't crosshd, 231 lbs.; main rod, 484 lbs.; side rod, 339 lbs.	
Cylinders.—Number	Two.
Diameter and stroke	21 × 28 ins.
Cubic contents of all cylinders	11.22 cu. ft.
Form of crosshead and guides	Two-bar; So. Ry. standard.
Connecting rod, length between centers	10 ft. 4 ins.
Side rod	Solid ends.
Valve Gear.—Type	Shifting link.
Ports, steam ...1⅞ × 19 ins.; Ports, exhaust	3 × 19 ins.
Bridges, width....1¼ " ; Eccentrics, throw	5 "
Slide valves, style	American balanced.
" maximum travel	5½ ins.
" inside clearance	1-16 in.
" outside lap	1 in.
" lead (full forward and backwrd gear)	1-16 in.
Boiler.—Type	Extended wagon top.
Diameter barrel, inside smallest ring	5 ft. 6⅝ ins.
Dome, diameter	2 " 8¾ "
Thickness, barrel plates, ⅝-in.; smokebox tube-plate	½-in.
Horizontal and circumferential seams	Double riveted.
Joints....Butt; Rivets, diameter	1 in.
Height from rail to center line	8 ft. 4¾ ins.
Length of smokebox (including extension)	5 " 8 5-16
Does smokebox arngmt. conform to M. M. A. rules?	No.
Spark arstg. device. Extension front, deflector and netting.	
Injectors, number ....Two; Kind	No. 11 Monitor.
Working steam pressure	200 lbs.
Firebox.—Type	Wide, radial stayed.
Length, inside...10 ft. 0 ins.; width inside	3 ft. 5⅞ ins.
Depth at front....6 " 3 " ; depth at back	5 " 0¾ "
Thickness, side plates .⅜-in.; back plate	⅜-in.

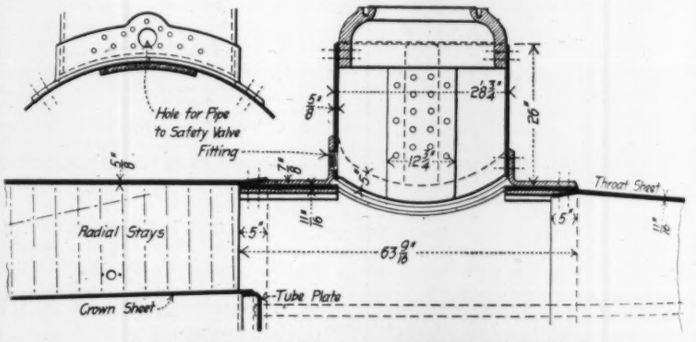


FIG. 2.—DOME CONNECTION OF TEN-WHEEL LOCOMOTIVE.

Thickness, crown plate⅝-in.; tube plate	½-in.
Crown stays ....Radial; Grate bars ...C. I.; rocking.	
Is fire-brick arch used?	Yes.
Stay bolts (drilled), diameter	1⅛ ins.
" pitch	4⅛ "
Water spaces, width, front, 4 ins.; back and sides, 3½	"
Tubes.—Material, charcoal iron; number	295
Thickness ...No. 12 B.W.G.; pitch	2⅝ ins.
Diameter, outside	2 "
Length over tube plates	14 ft. 5¼ ins.
Total area of tube openings	5.12 sq. ft.
Heating Surface and Grate Area:	
Heating surface, tubes (exterior area)	2,217.16 sq. ft.
Firebox....175.96; fire-brick arch tubes 17.14 "	
Heating surface, total	2,410.26 "
Grate area	34.90 "
Ratio of total heat. surf. to grate area	69.06
Ration of ext. tube area to firebox heat. surf.	12.69
Sq. ft. of total heat. surf. to 1 cu. ft. of cyl. vol.	214.24
Sq. ft. of firebox heat. surf. to 1 cu. ft. of cyl. vol.	15.64
Sq. ft. of tube heat surf. to 1 cu. ft. of cyl. vol.	198.60
Sq. ft. of grate area to 1 cu. ft. of cyl. vol.	3.10
Miscellaneous:	
Exhaust nozzle (single), diameter	5⅝ ins.
Exhaust nozzle, distance above c. line of boiler	14 "
Smokestack, diameter, top and base	16 "
" height above smokebox	4 ft. 0 "
" height of top above rail	15 ft. 1¼ "
Capacity of tender tank	4,500 gallons.

Capacity of coal space	14,000 lbs.
Brake fittings. American (drivers); Westinghouse (tender).	
Tractive force per lb. effect. press. on piston	171.51
Total tractive force with effective pressure equal to 85% of boiler pressure	29,160
Total adhesive tractive power at ¼ of weight on driving wheels	30,313
Ratio, tractive force to weight on driving wheels	0.240

NOTES FROM THE ENGINEERING SCHOOLS.

Cornell University.—Many of the alumni and seniors in the engineering departments are entering the army or navy. One of the alumni of Sibley College recently wrote Dr. R. H. Thurston, the Director of the College, who was in the Engineer Corps of the Navy himself during the civil war, asking advice concerning his going into the army or navy during the present war. We have been favored with Dr. Thurston's reply, which will be interesting to those who may be contemplating enlistment:

Dear Sir: Yours of the 28th is at hand, asking an opinion—as an expert, presumably—regarding the desirability of soldiering as a vocation.

My own experience was one which I have always felt extremely valuable, and I have always been glad that I was able to kill so many birds with one stone. I found myself better able to serve the country in the Engineer Corps of the Navy than I could have done anywhere else; secured a most varied, instructive and helpful experience; learned many things, as a moral and physical training, that I never should have imagined had I never left a comfortable home and a life of independence and self-assertion for one in which discipline, privations, dangers and hardships were occasionally experienced; derived comfort, pleasure and health, on the whole, from sea-going, obtained much information in professional matters, and helpful direction in professional studies; enjoyed a not unsatisfactory home on ship-board; always had the satisfaction of feeling, that if hurt, there was a bed and a surgeon right at hand, and if killed, I was certain of identification, and sure that my family would be left in no uncertainty. The life was pleasant, the mails pretty sure to come at not very irregular intervals, and visits to new ports, and now and then home, were likely to lend such pleasures as only one who has experienced them can realize.

The way to enter the navy is to address an application to the Secretary of the Navy, stating concisely your experience and abilities, professional and general, indicating thus to what extent your service would be likely to prove helpful, and asking orders to appear before the examining board at Washington or Philadelphia. Examinations at P. are such that you could readily pass; though largely on the practical routine of duty on board ship. I do not know about the other boards. Presumably they are all working under similar instructions. I think that all of our alumni, and all our seniors, who have tried them—and they are a considerable number—have passed readily.

The engineer regiments of the army will prove, I think, good—for army places. I personally prefer the navy, though, of course, no man would stickle for one or the other if the opportunity offered to do good service in either. Don't go as a private—for you can be more useful otherwise—unless, indeed, after a time, more serious work appears in prospect than now.

Don't go at all if you have any compunctions about leaving dependents. The emergency is not—not yet, at least—serious enough.

Yours very truly,

R. H. Thurston.

Sibley College, Cornell University, Ithaca, N. Y., May 31, 1898.

There are 438 candidates for degrees in the University this year, a number greater than the whole number of students in 1881. The growth of Cornell during the past year has been remarkable. Last fall the graduate school of railway mechanical engineering was established. Then the sons of the late Hon. H. W. Sage gave the University his $80,000 mansion and an endowment of $100,000 for an infirmary for students who may be ill at the University. Next the legislature authorized the establishment, under control of the trustees of Cornell, of a State College of Forestry, appropriated for its maintenance $10,000 a year, and authorized it to use State funds for the purchase of 30,000 acres of Adirondack forest land, for a demonstration area. Last of all, Col. Oliver H. Payne has created a Cornell University Medical College, with an experienced teaching staff of fifty or sixty of the greatest physicians and surgeons in New York, for whose salaries he has provided; and he is now arranging for a magnificent building for the College in New York city.

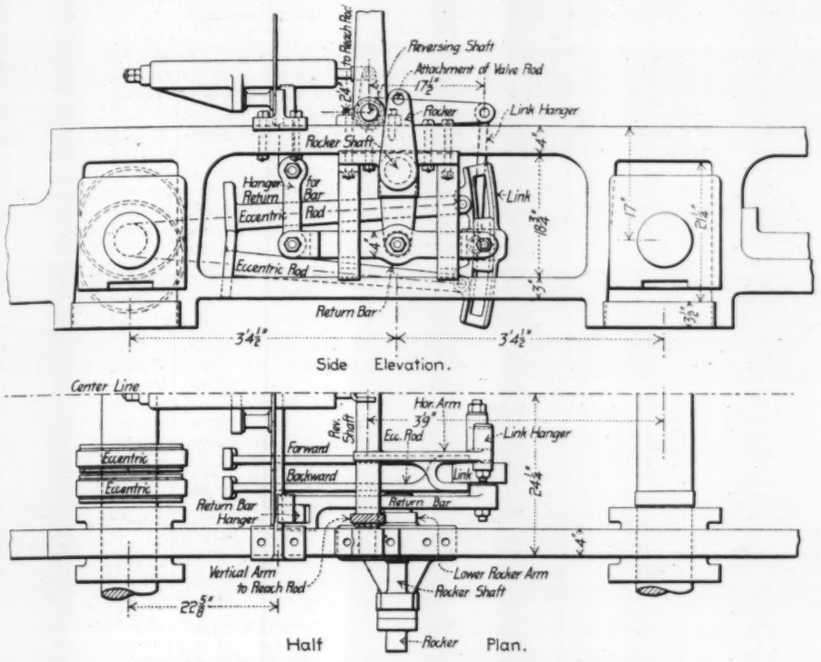


FIG. 3.—VALVE GEAR OF TEN-WHEEL LOCOMOTIVE; SOUTHERN RY.

Purdue University.—A pamphlet recently issued contains an announcement of courses in railway engineering and railway management. Purdue has for several years offered work covering a considerable variety of railway subjects, but, recently, to provide more perfectly for the railway interests, a department of railway engineering and management has been formed.

A new building, 50 × 100 ft., known as the Railway Laboratory, contains several important plants designed especially for research work in railway engineering. These are not duplicated in any laboratory in the world

The work of the department embraces 30 courses, all of which are open to graduate students, and many of them to undergraduates in the schools of civil, electrical and mechanical engineering. The names of these courses are as follows: 1. Railway Economics. 2. Railway Surveying. 3. Railway Construction. 4. Track Maintenance. 5. Tests of Track Materials. 6. Tests of Track. 7. Block and Interlocking Signals. 8. Water Supply Stations. 9. Design and Operation of Terminals. 10. Railway Chemistry. 11. Railway Sanitation. 12. Locomotive Design. 13. Locomotive Testing. 14. Locomotive Performance. 15. Locomotive Operation and Maintenance. 16. Tests of Locomotive Injectors. 17. Car Construction. 18. Tests of Car Materials. 19. Train Brakes and Signals. 20. Tests of Air Brake Materials. 21. Car Lighting, Heating and Ventilation. 22. Tests of Lighting Equipment. 23. Car Sanitation. 24. Interchange of Cars. 25. Tests of Atmospheric Resistance. 26. Train Rating. 27. Electric Railways. 28. Tests of Electric Equipment. 29. Steam vs. Electric Traction. 30. Visits of Inspection. Lectures, laboratory practice and study in the several subjects will be under the direction of several of the professors of engineering, chemistry, political economy, etc., in the University, Prof. W. F. M. Goss being in charge of the department. A course of lectures by non-resident lecturers will also be given. Among those who will take part during the year 1898-99 are the following:

W. H. Baldwin, President Long Island Railroal Company, New York. "The Routine of a Railway President."

Jacob N. Barr, Superintendent of Motive Power, C. M. & St. P. Railway Company, Milwaukee. (Subject to be announced.)

Charles B. Dudley, Chemist, Pennsylvania Railway Co., Altoona. "The Application of Chemistry to the Railroad."

Melville, E. Ingalls, President of the Big Four System, Cincinnati. "Railways; Their Past, Present and Future."

John W. Noble, ex-Secretary of Interior, St. Louis, Mo. "The Mutual Obligations of Railroad Corporations and the People."

Robert Quayle, Supt. Motive Power and Machinery, C. & N. W. Ry. Co., Chicago. "Business Problems of the Motive Power Department."

University of Wisconsin.—A unique kind of work is regularly done by the class in bridges, on the testing of bridges under moving trains. The University has recently purchased a complete set of autographic bridge testing apparatus, known as the Fraenkel design, including two instruments for measuring strains on individual members, and also a deflection instrument. These tests show to the student the approximate nature of the computed stresses, besides giving him some notion of effect of the moving loads. Prof. Turneaure expects soon to publish results of a series of experiments on several bridges made with this set of apparatus during the last summer.

The natural topography of the region in the neighborhood of the University, including the small lakes, gives fine facilities for work in topographical and hydrographical surveying. Students of the Sophomore and Junior classes are formed into surveying parties, and do work in these directions for two weeks after the close of the regular work.

In the hydraulic laboratory, recent additions to the equipment include a Venturi meter, a power pump for high heads, and a 15-HP. engine for operating the pump.

Lafayette College.—Since the fire last December, which destroyed, together with two-thirds of Pardee Hall, that portion of the college building devoted to civil engineering, arrangements have been made to enlarge the size and improve the facilities of all laboratories connected with the civil engineering department. The testing laboratory will occupy two floors, the room being 30 ft. by 60 ft. To the very complete outfit of apparatus previously occupying this laboratory will be added a 500,000-lb. testing machine. Adjacent to this laboratory will be a well-equipped machine shop. The cement laboratory will be furnished with apparatus for making all the standard tests, including, besides three briquette testing machines of different makes, special machinery for eliminating personal equations in mixing, etc. The hydraulic and sanitary laboratory will be greatly enlarged, and will carry two floors, above which will rise a stand-pipe 50 ft. high. Water will be delivered by a pump drawing its supply from a cistern, into which it again flows after leaving the laboratory. City water can also be used with a head of 100 ft. Two 5-ft. tanks, one 20 ft. high, for orifice experiments; a Venturi meter; a large weir box and measuring tank; a turbine and a Backus wheel; and arrangements for testing nozzles, valves, fire hydrants, etc., are among the appliances to be provided. Arrangements are made for conducting many of the experiments in the lecture room, which is immediately above, and communicates with the laboratory. For conducting the waste water to the cistern are lines of 4-in., 6-in., 8-in. and 10-in. salt-glazed sewer pipe, each about 230 ft. long, arranged with piezometer, Pitot's tubes, etc., for observing the flow. This pipe was the gift of the Great Western Fire Clay Co.

There will be also an instrument adjusting room, a library and a reading room for the special use of this department, besides draughting rooms, lecture rooms, etc. All of the above are now well under way and will be ready for use next September.

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ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page 28. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The recent introduction of freight cars of 80,000 lbs. to 110,000 lbs. carrying capacity brings up again the "large car" question, which is always a fruitful subject for discussion among railway officials of the operating and car departments, and which was discussed at some length in our columns about two years ago (Eng. News, March 12, 1896). As is well known, the 60,000-lb. car which has been for the past few years practically the standard, dates back only to about 1885. In 1875, the normal capacity was from 20,000 to 25,000 lbs., and in 1885 this normal capacity had grown to 40,000 and 50,000 lbs. In that year a committee of the Master Car Builders' Association made a report recommending certain standard dimensions for 60,000-lb. cars, but such cars were then quite exceptional. Few cars of less than 60,000 lbs. capacity are now built for ordinary freight service, but on the other hand there is a decided tendency to increase the capacity to 70,000 and 80,000 lbs. Several roads are now using cars of such capacity, including the Illinois Central R. R., whose 80,000-lb. coal cars are described in another column. Even this is not the limit, however, for several hundred steel cars of 100,000 lbs., and even 110,000 lbs. capacity, are in service. Practically all of these high capacity cars are in use on roads having a large coal and ore traffic, and are intended specially for this traffic, in which they can be assured of full loads (in one direction at least), thus approaching to the full measure of economy due to large car loads. The Pennsylvania Co., the Baltimore & Ohio R. R., and the Pittsburg, Bessemer & Lake Erie R. R. possess exceptional opportunities for benefiting by economy in operation in this way on their lines between the Pittsburg district and the Lake Erie ports. A large proportion of the traffic on these lines consists of northbound trains carrying coal to the lake ports, and southbound trains carrying ore from the lake steamers to the Pittsburg manufacturing district, so that the cars have full loads each way. The P., B. & L. E. R. R. has been specially improved for this traffic, grades having been reduced, 100-lb. rails laid, and heavy mogul engines put in service which can haul loaded trains of 30 cars of 100,000 lbs. capacity.

The 80,000-lb. cars appear to be gradually creeping into interchange service, in spite of the protests that have been made against such high-capacity cars, but it does not seem likely that the still larger cars will be used for such service for a long time. While these latter cars possess certain advantages for, and will probably be used even more extensively in, such special kinds of traffic as above noted, their economy would disappear with light loads, while with full loads on many lines the economy in operation would be largely offset by increased expenses in maintenance of way and structures. Several years ago, when the economy due to large car loads began to be recognized, a bold attempt was made to introduce 80,000-lb. coal cars, but as the car departments objected to the loads on the journals and the engineering departments objected to the wheel loads on account of their detrimental effect upon track and structures, an extra truck was added under the middle of the car. These cars, designed by Mr. Finlay, were used to some extent on the Erie R. R. and the Lake Shore & Michigan Southern Ry., and were described and illustrated in our issues of April 19, 1890, and March 19, 1896. While these cars were rated at 80,000 lbs., they carried loads as high as 100,000 lbs., which would give a distributed load of 10,834 lbs. per wheel. The modern cars of 80,000 and 100,000 lbs. capacity, however, are mounted on a pair of four-wheel trucks in the usual way, and those of the latter capacity are built entirely of steel. The following table gives an interesting comparison of the several high-capacity cars above mentioned:

Railways.	Material.	Ratd capacity, lbs.	Weight, Empty, lbs.	Weight, Loaded, lbs.	Pr whl, lbs.	Journals, ins.
L. S. & M. S. & Erie (3-truck)	Wood.	80,000	30,000	110,000	9,167	3¾× 7
Ill. Cent.	Wood.	80,000	31,500	111,500	13,938	5× 9
P.B.& L.E.	Steel.	100,000	34,000	134,000	16,750	5× 9
L.Sup. & I.	Steel.	100,000	26,000	126,000	15,750	5× 9
Balt. & O.	Steel.	100,000	34,000	134,000	16,750	5½×10
Penn. Co..	Steel.	110,000	34,000	144,000	18,000	5½×10

Municipal ownership of electric lighting plants received a considerable share of attention at the annual meeting of the National Electric Light Association, held in Chicago last week, but though the members of the association mainly represent companies, and are, therefore, naturally opposed to municipal ownership, they did not present any very convincing arguments against that system or in support of corporate ownership. The old stock argument was made use of, to the effect that municipalities are not morally competent to manage such plants, but will utilize them as political machinery, and give an inefficient service at great expense. The speakers admitted, however, that the electric light companies are themselves largely to blame for the existing public antagonism towards them by their arbitrary treatment of the public, by the devious and uneconomical methods which they pursue in dealing with competitors, and by the fact that they often deal very arbitrarily with their customers in the way of exorbitant charges and poor service. These conditions were admitted to exist to such an extent as to account for the agitation in favor of municipal control. It does not appear, therefore, that the corporate side of the question has any great advantage in regard to moral capacity. Although the advantages of public supervision or control of corporations performing public service were admitted, it did not seem to occur to any of the speakers that the suggested improvements in the conduct of corporate enterprises might equally well be introduced in the conduct of municipal enterprises, and that if municipalities are competent to control they may also be competent to run and operate such enterprises. The discussion, of course, included sarcastic references to the "impracticable theories" of municipal reformers, and to the growth of municipal ownership into a municipal socialism which will provide food and clothing and perform various other services for the public, but as these are not arguments, they need be given no attention.

A compromise view of the situation was taken in a paper on the subject, presented by Mr. Alex. Dow, of Detroit, in which the conduct of the lighting companies was somewhat sharply arraigned for shady ways of manag[illegible], and it was suggested that a possible outcom[illegible] of the friction between the companies and the public may be city ownership of the plant, combined with operation by a contractor, which is a system already in use with street railways. It was distinctly claimed, however, that a city should interfere with public lighting only, the supply of light to private users not being properly a municipal function. On the other hand, it was stated that the most economical method would be public lighting under contract by a private plant in connection with the supply of light to private users. Mr. Dow expressed his views by stating that (1) the tendency of public opinion appears to be toward public interference with corporations performing so-called public services; (2) that this is part of a general movement, and (3) that the main result of such a movement is beneficial, any damage to individual rights being incidental or due to needless individual opposition. These remarks were strongly condemned in the discussion which followed; the speakers objecting "on principle and as taxpayers" to municipal interference in any shape or form. The fact that there are now between 300 and 400 municipal plants in operation in this country would seem to call for some stronger argument than mere denunciation of municipal ownership; but, as already noted, the speakers were strongly prejudiced. Present indications are that the movement towards municipal ownership is growing, and will grow in spite of opposition.

THE CONDUCT OF THE WAR.

Our English contemporary, "The Engineer," has undertaken to give from week to week a critical account of the military and naval operations in the present war between the United States and Spain, and its comments are interesting as coming from an authority without prejudice in favor of either side, and which is supposed to be competent to bring some sort of expert knowledge to bear upon the subject at issue. We have already reproduced some of "The Engineer's" comments in our columns, and we present below nearly in full a leading article in its issue of June 3, which contains, together with some very intelligent comments, certain criticisms which ought not to go unanswered. We reprint the article as follows, and have commented upon it below:

It is so much easier to criticise operations of war than to conduct them, that any reasonable writer will use moderation in the remarks he is tempted to make, because matters generally go wrong in so many unforeseen ways, while information not obtainable by the combatants is in the possession of the critic. Consequently he is tempted to take an exaggerated view of mistakes which prevent the display of the skill for which he looks if he is an enthusiast. We may, however, curb ourselves and discount any few remarks we have to make on the Spanish-American war, and still feel compelled to say that, viewed as a war, the operations have been singularly unfortunate. Poor in conception and lame in action they appear to the world generally.

We all know that two nations unprepared for war were likely to do nothing decisive for some time, but that hardly expresses what we have witnessed. The Americans possessed no army ready for operations on land, but they, at all events, had a nucleus of one, and generals who might be trusted to develop their powers and judge what they could undertake; and their fleet, though consisting of heterogeneous vessels, was powerful out of all proportion to that of Spain. The United States have a few powerful men-of-war up to date, a few—but very few—swift and powerful cruisers, armored and unarmored, with a number of coast defense and old-fashioned vessels. No doubt this is not a handy shape in which to have naval power. Such a fleet does not lend itself to the delivery of striking masterly blows; but considering that the main seat of war is an island near their coast, and a long way from Spain, it would be difficult to find conditions better suited to the United States navy. If not good for operations close to their doors, what is their fleet good for? What was possible for it to do, or what might we reasonably expect, it may be asked.

We will endeavor to make some reply. We take the region principally concerned, that of Cuba, first. Well, we expected a fair attempt at a blockade, supplemented by a system of scouting such as would secure good information being obtained and prevent surprise; and, lastly, we expected a landing to be effected in Cuba with the establishment of supplies of food and arms to the insurgents, such as would prevent discouragement and suffering, and would prepare the way for the United States army when sufficiently formed to land and sweep all before it.

What has been done? The fleet has so little carried out a blockade that a powerful division of Spanish ships has gone, if we may believe anything reported, into Santiago de Cuba without the American fleet being for a long time able to find out for certain whether they are there or somewhere widely distant. The blockade and scouting has then, so far, broken down. The fleet, in fact, instead of doing one thing as well as circumstances admitted, has divided and tried whether something could not be affected at Puerto Rico, and naturally little or nothing has been done. We say naturally, for no one knows better than American officers themselves that ships firing at shore batteries effect little or nothing except under specially favorable conditions. The United States report, by Captain Goodrich, on the bombardment of Alexandria, was clear enough to define what ships could do against forts. It sounds sarcasm to say that the United States warships, with a considerable expenditure of ammunition, made a good deal of earth and stones fly, killed a mule, and made some men run. In reality little more than this was to be expected, little more could be done on land, unless the ships closed in, anchored, and pressed home an attack on some fort or harbor worth the loss and expenditure of ammunition involved. Skirmishing with land forts seldom pays.

A few insignificant Spanish ships have been captured, but this must have happened incidentally under any circumstances. Until quite recently no landing has been effected in Cuba, because no sufficiently-planned and serious effort has been made. It was skirmishing rather than the definite establishment of the depot and organized system of supply that many of us expected. Surely the Americans, possessing as they do soldiers and sailors of ability, must feel that there has been a want of definite plan and an absence of result which, under the circumstances, is melancholy.

Then, again, the fears of coast attack from the Spanish cruisers seem to us greatly exaggerated. In time of war we must make up our minds to the possibility of damage, but as we have pointed out before now, the supply of ammunition carried by a ship in its normal state is very limited. A considerable part of it is only suited to attack armor, and a fleet performing a raid, and liable to meet an enemy, can spare so little for incendiary work on land, that a government might well afford to promise compensation to any sufferers, on the strict condition that no money should be paid to the enemy to secure immunity. The Spanish might fire a few hundred common shell and set on fire a part of some one town, and there their power would be ended, and they would be happy if they escaped the clutches of the superior American fleet.

If, however, the United States operations have been disappointing, what can be said for those of Spain? With all her inferiority, Spain had one strong element, namely, a powerful group of cruisers combining speed and powers of attack and defense in an unusual measure. Twenty knots speed with a 6-in. Harveyed steel belt and 6-in. quick-firing guns, besides the 10-in. pieces, represents great fighting power. This remarkable combination is found in the "Christobal Colon"; 20 knots speed, with a 12-in. belt and 5 5-in. quick-firing battery supporting two 11-in. guns, is found in the "Princesa de Asturias." The "Vizcaya" has 20 to 21 knots speed, a 12-in. belt, two 11-in. guns, and ten 5.5-in. quick-firing guns, and so on. Thus Spain could bring together some six or seven armored cruisers of 20-knot speed, with which might be associated one or two unarmored 20-knot cruisers.

Seeing that the States had only two armored and two unarmored cruisers of this speed, there existed an element that a talented commander might use, and with which he might perhaps effect something worth doing. Not, we believe, against towns on shore, but perhaps by threatening points or ships he might use his ships in such a way as to detach such a part of the United States fleet as might be defeated, and who could say what this might lead to? The role suggested is not easy, especially as to coal supply; still, something might be attempted.

What has actually been done? So far as we can learn, these swift cruisers have been divided, and half of them, that is to say, the "Infanta Maria Teresa," "Vizcaya," "Almirante Oquendo" and "Christobal Colon," have been taken by Admiral Cervera safely into the harbor of Santiago de Cuba. That is to say, no American ships had been met with, and nothing has been so far effected by this fleet except the entrance into a harbor now beset by all the most powerful ships in the American navy. Will this fleet remain unable to perform anything till a day of surrender? It seems possible, although we must bear in mind that, with higher speeds than their enemy, it is conceivable that they might get up steam and slip past the American ships, especially if they catch these with their fires banked.

Yesterday morning came the news of heavy firing, but it is probable that no result has been effected beyond knocking down some old-fashioned masonry at the cost of much valuable ammunition. The "Iowa," "Texas" and "Massachusetts" represent all the best United States battleships, except the "Oregon." Can it answer to pit these against earthworks and masonry, with the increased chance of the Spanish ships taking advantage of the low ebb of ammunition to slip out? The fact is that beyond the increased chance of capture of these Spanish ships at the conclusion of the war, the operations at Santiago de Cuba can hardly have a decisive effect. For this end a considerable part of the American fleet must remain lying outside the harbor to secure a preponderance of force. Probably torpedo boats would be specially valuable, as they ought not to lose much time in getting up steam. It is interesting to see how this will end. But is Cervera really in Santiago at all?

As to this very fine squadron of Spanish cruisers, there was a moment when a very different object appeared to be possibly in contemplation. After the Spanish loss at Manila, Cervera's cruisers were said to be at the Cape Verde Islands. Consequently, had he gone to the Philippines, he must have reached them many days before any American ships could get there. It was certainly to be feared that at some point information might be given to America which might be followed by telegraphic order to Captain Dewey to leave Manila, but this only amounts to saying that the worst that could happen would be that Spain would recapture Manila, and give an example that the United States fleet declined action. On the other hand, had they found Captain Dewey's fleet, they must have destroyed it as certainly as he annihilated their own weak ships which he found at Manila. No doubt impossibility of obtaining sufficient coals may have forbidden this enterprise; but, on the other hand, it may be due to Spanish ambition to contend with the main American fleet at the principal seat of war.

The consideration of the Philippines brings us, however, to the one part of the war where we can cordially admire both Americans and Spanish. Considered as an operation of war, the attack at Manila can only be spoken of in a qualified way. With our views of the limited power of ships for shore operations, our readers will not be surprised at our not expecting to hear that Captain Dewey's action had to be checked at once, probably for want of ammunition and men. How could it be otherwise? We believe that the Spanish need not at all have dreaded what he might do to the town. The few shells he had left would soon have been gone. It is curious to think how completely he was a possible prey for Admiral Cervera, so far as we can see, so that we watched for some days to learn what would happen. The fact is that the best foundation for Captain Dewey's enterprise was the possibility that the insurgents might help him to establish himself. He may have had better information as to the rotten state of the Spanish defenses than appears, but under any circumstances we may well admire the daring that made him thrust his ships into a harbor that they had no business to be able to enter if any tolerable elements of defense had existed, and we must also admire the great bravery of the Spaniards, who fought their hopelessly weak ships to the last, and went down with their colors flying. By the way, we wonder whether Captain Concha, who fought the "Don Juan de Austria" so gallantly, is the same who pluckily sailed the model of Columbus' vessel out to the World's Fair at Chicago, and who then figured as a cheery little judge in the Transportation Branch. If so, we think the Americans must be specially glad that he survived. To conclude, the Spanish had one trump card in their hand. So far as we can make out they have thown it away. The sooner they make peace now the better.

The most important point in which our contemporary "sips up" is in its assertion that the entry of Cervera's fleet to the port of Santiago proved the ineffectiveness of the American blockade. As expressed in another place in the same issue of the same journal, "Admiral Cervera has already shown that the assumed blockade of Cuba is merely a shadow and a name."

We need hardly explain to our American readers that "The Engineer" makes an egregious blunder when it assumes that the United States fleets had blockaded Santiago previous to Cervera's entrance. The ports of Cuba which were declared blockaded by President McKinley's proclamation were only those around the western part of the island, the only part, we may remark, which has rail communication with Havana. The Port of Santiago has never been declared to be blockaded. Thus "The Engineer's" proof that the United States blockade is "a shadow and a name" is shown to be entirely false. Its error was doubtless made through ignorance; but unless it publishes a correction, it will be guilty of seriously misleading its readers upon a very important matter.

The second point in which "The Engineer" thinks our naval operations have been inefficient is in the matter of scouting. It thinks that the naval scouts should "ensure good information being obtained and prevent surprise." What reason has "The Engineer" to believe that the American scouting vessels have not done this as well as was possible? Does it imagine that it or any other newspaper here or abroad is in possession of even a fragmental part of the information which the scouting vessels have furnished to Sampson and Schley? What fault has it to find with the results thus far shown of the American scouts' work? Have our fleets been "surprised" at any point? Suppose Cervera did sail from Martinique to Santiago without being shadowed by the "Paris," an operation let it be remarked attended with the greatest risk to the scouting vessel. Has not the event proved that it was quite as well to let him sail in fancied security into the trap as to harass him by scouts, on his voyage in the Caribbean?

Taking up next our contemporary's criticism of Sampson's attack on Porto Rico, we can only say that it betrays so dense an ignorance of the situation that we can only answer it by stating some facts which are now matters of history.

When Cervera's fleet was known to have sailed westward from the Cape Verde Islands, what was the evident course for the United States fleet to pursue? Manifestly it was to prevent Cervera from entering the only two well fortified Spanish ports on this side of the Atlantic, San Juan and Havana, where, if he once effected an entrance, the American vessels would have to cope both with ships and fortifications. If Cervera's fleet had been able to recoal and refit in either of these ports, it could then have started out on a long cruise, which might have proved very disastrous to the United States. Let it be remembered that the Spanish vessels were superior in speed to all the vessels of the American navy, save a few cruisers far inferior in armor and armament; and the American battleships were too slow to catch Cervera's cruisers if they ever came up with them.

Bearing this in mind, it is easily seen how important it was to the United States that Cervera's fleet should not be permitted to recoal in San Juan or Havana, and that if they entered any other port of the Spanish Antilles, they should be penned up in it by the heavily armored vessels of the United States fleet before they could complete recoaling and issue forth.

Sampson's expedition to San Juan was for the sole purpose of preventing Cervera's squadron from entering that port, which was its natural destination; and the expedition was successful. Cervera arrived at Martinique, found that he would have to fight Sampson's superior fleet to enter San Juan, and took the only alternative course of sailing for a Cuban port. "The Engineer" appears to labor under the delusion that Sampson's so-called bombardment of the San Juan fortifications was the object for which he went to Porto Rico. Nothing could be further from the truth. Our contemporary ought to know that the newspapers magnify the importance of all engagements, and Sampson's few shots at the San Juan forts were made much more of than their importance deserved by most of the daily papers. American naval commanders believe in target practice; there is no experience like actual battle for training the fighting forces of a ship. Sampson went to San Juan, we repeat, to head off Cervera; but with his powerful squadron before the fortifications, he would have come short of his duty if he had not engaged them sufficiently to determine their strength and position and incidentally to give his men some valuable experience in handling their guns in action. It may be said that he ran some risk in this, but risks must always be taken in warfare, and events proved that the risk was trifling.

Let us turn now to Cervera's entry into Santiago, which "The Engineer" seems to think was a notable achievement on the part of the Spanish admiral. We trust our contemporary has ascertained by this time that this was the place of all places where the American commanders wanted him to go. Had he gone to Cienfuegos instead, he would have been in rail communication with Blanco's forces at Havana and could have received reinforcements and supplies from there. Had he entered any port on the western part of Cuba there might have been some color for the assertion that our blockade had been broken. As it is we have the four best vessels of the Spanish navy shut up in a harbor from which their escape has been made practically impossible, and which

will soon be so surrounded by the United States land forces that the surrender of the Spanish vessels will be only a matter of time. We think that "The Engineer" may yet see reason to change its mind as to the decisive effect of the operations at Santiago.

As for the criticism of the United States for not sooner invading Cuba, we can only say that it was not possible for us to raise an army of invasion in time to rescue and relieve the starving reconcentrados. It has been our policy to run no unnecessary risks, to make victory certain at every point of action, to see that no losses of life were incurred by our forces unless some advantage worth the cost were to be gained. It is far better tactics in warfare to attack and capture by superior force the weaker positions of an enemy than to run unnecessary risk in the attack of better defended positions until such attack becomes necessary. The United States is under no necessity of haste. Every week and month brings Spain nearer the end of her financial resources, and nearer the point where she will be obliged to sue for peace.

As for "the fear of coast attacks from the Spanish cruisers" which seems to "The Engineer" so greatly exaggerated, we are quite certain that the United States authorities are not losing much sleep over the chances of a raid on Atlantic coast cities by Spanish cruisers. Proper precautions to meet such an attack have, of course, been taken, and the "greatly exaggerated fear" to which "The Engineer" alludes exist, if they exist at all, only in the minds of some of the more timid residents along the coast. There is no more reason to suppose that these fears are shared by those at the head of the United States military and naval forces than there is to believe that the English opposition to the proposed channel tunnel, as furnishing a possible avenue for foreign invasion, has been fomented by the heads of the British War Office.

Our contemporary's criticism of the Spanish plan of campaign, or, more properly, lack of plan, is for the most part sound, though his censure of the Spanish for not preventing Dewey's entrance to Manila Bay seems undeserved. If we are rightly informed, the entrance to this Bay is too broad and deep to admit of its being closed against an enemy by mines; and the fortifications on Corregidor Island would require far heavier and better guns than the Spanish possessed to have seriously endangered the entrance of Dewey's fleet.

We can fully agree with our contemporary, however, that Spain's fast armored cruisers, if they were in the condition they ought to have been, and if they had been maneuvered and fought with ability, had it in their power to do a very considerable amount of mischief; and while they could not have affected the ultimate outcome of the war, they might have at least done something to satisfy the sense of "honor," which has brought Spain to its present position. With the best four of these cruisers bottled up in Santiago Bay, however, "The Engineer's" advice to the Spaniards to treat for peace at once is undoubtedly sound.

LETTERS TO THE EDITOR.

Computing Frog Angles.

Sir: On pp. 250 and 251 of your issue of April 21, you publish a discussion of railway crossing frogs by Mr. G. B. Zahniser, in which he states that he has been unable to find the necessary formulas derived in railway hand-books. Allow me to state that on pp. 170 and 171 of Nagle's "Field Manual for Railroad Engineers" the subject is discussed, the data employed being the same that Mr. Zahniser used—viz.: the radii and gages of intersecting tracks and the angle made by their center lines—but the resulting formulas are simpler and more easily applied. Crossing frogs are also treated in Carhart's "Field Book for Civil Engineers" on pp. 147 to 152, inclusive, but one of the frog angles is supposed to be known in the beginning, whereas the angle that is measured in the field is the angle between center lines of track. Nagle's "Field Manual," pp. 172 to 175, and Carhart's "Field Book," pp. 152 to 157, also discuss crossing slips, which may occur in connection with crossing frogs.

Yours truly, D. W. Spence.

College Station, Tex., April 25, 1898.

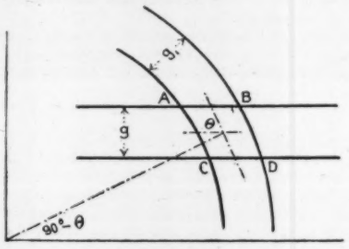
Sir: Perhaps the following method, which I have used for calculating frog angles where a straight track intersects a curved track, may not be without interest to your readers. I have not been able to find formulas of the kind in text books:

Let R be the radius corresponding to the degree of curvature.

Let Θ be the angle of intersection at center of tracks.

Let g = gage of straight track.

Let g_1 = gage of curved track.



Referring to rectangular co-ordinates with the origin at the center of curvature, the ordinates of the several points of intersection will be

$$\text{For A and B, } y = r \operatorname{Cos} \Theta + \frac{g}{2}.$$

$$\text{For C and D, } y = r \operatorname{Cos} \Theta - \frac{g}{2}.$$

Therefore

$$\operatorname{Cos} A = \frac{r \operatorname{Cos} \Theta + \frac{g}{2}}{r - \frac{g_1}{2}};$$

$$\operatorname{Cos} B = \frac{r \operatorname{Cos} \Theta + \frac{g}{2}}{r + \frac{g_1}{2}};$$

$$\operatorname{Cos} C = \frac{r \operatorname{Cos} \Theta - \frac{g}{2}}{r - \frac{g_1}{2}};$$

$$\operatorname{Cos} D = \frac{r \operatorname{Cos} \Theta - \frac{g}{2}}{r + \frac{g_1}{2}};$$

From which the angles can readily be calculated.

Yours truly, Robert S. Bell.

Louisville, Ky., April 26, 1898.

Railway Crossing Frog Formulas.

Sir: Like Mr. G. B. Zahniser, whose article on "Railway Crossing Frog Formulas" appearing in Engineering News of April 21, 1898, the writer looked in vain some years ago for satisfactory track crossing formulas.

The two cases submitted are among those which were part of his experience while designing crossings to replace old, worn-out ones in use, hence the data given are only such as could be measured with a straight-edge (to get ordinates on curves) and a tape line, and as they differ in the assumptions of G B Z, he will take pleasure in their publication.

Case I.—To find the frog angles, and distances vertex to vertex on gage lines when one straight track crosses a curved track (Fig. 1) having the radius of curves given and distance vertex to vertex A C. It may be noted that by substitution of letters (on diagrams where two parallel-curved tracks cross a straight track, or two parallel-straight tracks cross one curved one) two adjoining gage lines crossings of said type may be calculated by the same formulas.

Let R = O C, and r = O A. Join center of curves with crossing points.

The frog angles at A, B, C and D are the angles between the tangent to curve at those points and the straight track line, and will be designated by those letters.

$$S = \tfrac{1}{2}(R + r + X). \quad (1)$$

$$\operatorname{Sin} \tfrac{1}{2} A C O = \sqrt{\frac{(S - X)(S - R)}{R \times x}}. \quad (2)$$

$$\operatorname{Sin} \tfrac{1}{2} A O C = \sqrt{\frac{(S - r)(S - R)}{R \times r}}. \quad (3)$$

$$\operatorname{Sin} \tfrac{1}{2} C A O = \sqrt{\frac{(S - r)(S - X)}{r \times X}}. \quad (4)$$

$$\operatorname{Sin} A C E = \frac{A E}{A C}. \quad (5)$$

$$\text{Angle } B A O = C A O + A C E. \quad (6)$$

$$\operatorname{Sin} A B O = \frac{\operatorname{Sin} B A O \times r}{R}. \quad (7)$$

$$A O B = 180° - (B A O + A B O). \quad (8)$$

$$B O C = A O C - A O B. \quad (9)$$

$$D C O = A O C - A C E. \quad (10)$$

$$O D C = \frac{\operatorname{Sin} D C O \times R}{r}. \quad (11)$$

$$D O C = 180° - (D C O + O D C). \quad (12)$$

$$A O D = A O C - D O C. \quad (13)$$

$$A B = \frac{\operatorname{Sin} A O B \times R}{\operatorname{Sin} B A O}. \quad (14)$$

$$D C = \frac{\operatorname{Sin} D O C \times R}{\operatorname{Sin} C D O}. \quad (15)$$

$$A D = 2 \operatorname{Sin} A O D. \quad (16)$$

$$B C = 2 \operatorname{Sin} B O C. \quad (17)$$

Frog angle at A = B A O − 90°.
" " B = 90° − A B O.
" " C = 90° − D C O.
" " D = C D O − 90°.

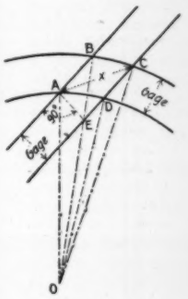


Fig. 1.

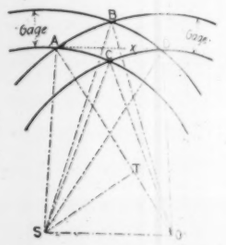


Fig. 2.

Case II.—To find frog angles, and distances from vertex to vertex when both tracks are curved in the same direction (Fig. 2) having the radii of curves given and distance vertex to vertex A D.

Let A D = X.

In triangle A D O, let (A D + D O + O A) = S.

$$\operatorname{Sin} \tfrac{1}{2} A O D = \sqrt{\frac{(\frac{1}{2} S - A O)(\frac{1}{2} S - D O)}{A O \times D O}}. \quad (1)$$

$$\operatorname{Sin} \tfrac{1}{2} O A D = \sqrt{\frac{(\frac{1}{2} S - A O)(\frac{1}{2} S - X)}{A O \times X}}. \quad (2)$$

$$\operatorname{Sin} \tfrac{1}{2} A D O = \sqrt{\frac{(\frac{1}{2} S - D O)(\frac{1}{2} S - X)}{D O \times X}}. \quad (3)$$

In triangle A D S,

$$\operatorname{Sin} \tfrac{1}{2} A D S = \sqrt{\frac{(\frac{1}{2} S - X)(\frac{1}{2} S - D S)}{X \times D S}}. \quad (4)$$

$$\operatorname{Sin} \tfrac{1}{2} D S A = \sqrt{\frac{(\frac{1}{2} S - D S)(\frac{1}{2} S - A S)}{D S \times A S}}. \quad (5)$$

$$\operatorname{Sin} \tfrac{1}{2} D A S = \sqrt{\frac{(\frac{1}{2} S - X)(\frac{1}{2} S - A S)}{X \times A S}}. \quad (6)$$

The frog angles at A, B, C and D are the angles made by tangent lines to each curve at those points and will be designated by those letters.

$$\text{Frog angle A} = S A D - D A O. \quad (7)$$

$$\text{Frog angle D} = A D O - A D S. \quad (8)$$

In triangle S A O,

$$S T = \operatorname{Sin} S T A \times S A. \quad (9)$$

$$\operatorname{Sin} S A T = \frac{S T}{S A}. \quad (10)$$

$$A S T = 90° - S A T.$$

$$T O = A O - A T.$$

$$S O = \sqrt{S T^2 \times T O^2}. \quad (11)$$

In triangle O S T,

$$\operatorname{Sin} O S T = \frac{T O}{S O}. \quad (12)$$

$$\operatorname{Cos} A O S = \frac{T O}{S O}. \quad (13)$$

$$A S O = A S T + T S O.$$

In triangle S B O,

$$\operatorname{Sin} \tfrac{1}{2} S B O = \sqrt{\frac{(\frac{1}{2} S - S B)(\frac{1}{2} S - B O)}{S B \times B O}}. \quad (14)$$

$$\operatorname{Sin} \tfrac{1}{2} S O B = \sqrt{\frac{(\frac{1}{2} S - S O)(\frac{1}{2} S - O B)}{S O \times O B}}. \quad (15)$$

$$\operatorname{Sin} \tfrac{1}{2} O S B = \sqrt{\frac{(\frac{1}{2} S - O S)(\frac{1}{2} S - S B)}{O S \times S B}}. \quad (16)$$

In triangle S C O,

$$\operatorname{Sin} \tfrac{1}{2} S C O = \sqrt{\frac{(\frac{1}{2} S - S C)(\frac{1}{2} S - C O)}{S C \times C O}}. \quad (17)$$

$$\operatorname{Sin} \tfrac{1}{2} S O C = \sqrt{\frac{(\frac{1}{2} S - S O)(\frac{1}{2} S - O C)}{S O \times O C}}. \quad (18)$$

$$\text{Sin } \tfrac{1}{2} \text{ O S C} = \sqrt{\frac{(\tfrac{1}{2}\text{S} - \text{S O})\,(\tfrac{1}{2}\text{S} - \text{S C})}{\text{S O} \times \text{S C}}}. \quad (19)$$

Frog angle B = S B O.
Frog angle C = S C O.

In triangle S D O,

$$\text{Sin } \tfrac{1}{2} \text{ S O D} = \sqrt{\frac{(\tfrac{1}{2}\text{S} - \text{S O})\,(\tfrac{1}{2}\text{S} - \text{O D})}{\text{S O} \times \text{O D}}}. \quad (20)$$

$$\text{Sin } \tfrac{1}{2} \text{ D S O} = \sqrt{\frac{(\tfrac{1}{2}\text{S} - \text{D S})\,(\tfrac{1}{2}\text{S} - \text{S O})}{\text{D S} \times \text{S O}}}. \quad (21)$$

$$\text{Angle A S C} = \text{A S O \& C S O}; \quad \text{A C} = 2 \text{ Sin } \tfrac{1}{2} \text{ A S C} \times \text{A S}. \quad (22)$$

$$\text{Angle C O D} = \text{D O S} - \text{C O S}; \quad \text{C D} = 2 \text{ Sin } \tfrac{1}{2} \text{ C O D} \times \text{D O}. \quad (23)$$

$$\text{Angle B S D} = \text{B S O} - \text{D S O}; \quad \text{B D} = 2 \text{ Sin } \tfrac{1}{2} \text{ B S D} \times \text{B S}. \quad (24)$$

$$\text{Angle A O B} = \text{S O B} - \text{A O S}; \quad \text{A B} = 2 \text{ Sin } \tfrac{1}{2} \text{ B O A} \times \text{A O}. \quad (25)$$

Yours truly,

Wm. Wallace Christie,
M. Am. Soc. M. E.

5-7 Dey St., New York., April 22, 1898.

Notes and Queries.

W. J. F., Peterboro, Ont., asks which form is preferable as standard practice in a drafting room, 7.'96 or 7.96'? also, whether it is better to use dashes in such an expressure as 5°—15'—14"?

Our standard practice in the drawings reproduced in Engineering News is to place the sign for feet or inches over the decimal point as 7.'96. This can be done more neatly by a draftsman than it can be shown in type. In this way the sign for feet or inches assists the eye in locating the decimal point. We do not use the dashes, the space left and the symbol are sufficient to separate the numbers.

"Subscriber" writes: "In computing the fiber stress of rack teeth for operating machinery of draw-spans, some engineers hold that, besides the usual assumption for unbalanced wind pressure upon one arm of the span, an allowance should be made for acceleration of mass; also an allowance for journal and collar friction on the part of the track rollers. Can you, or some one of the readers of your journal, state what would seem to be a reasonable amount to allow for acceleration, and what amount for friction?"

MUNICIPAL OWNERSHIP OF ELECTRIC LIGHT PLANTS.

The questions of municipal and corporate ownership of electric light plants, and the relations between the public and the lighting companies were prominent in the proceedings of the annual convention of the National Electric Light Association, held at Chicago, June 7 and 9. These questions were discussed mainly from the standpoint that there should be no municipal interference, and the suggestion made that there is a growing movement in favor of such interference drew forth some very vigorous remarks. We have commented on the subject in our editorial columns, and give herewith an abstract of those parts of the proceedings which dealt with the subject.

In the opening address, delivered by the President, Mr. Samuel Insull (President of the Chicago Edison Co.), this question was discussed as follows:

A subject of growing importance to a number of our members is the question of the public ownership and operation of the undertakings now operated by electric lighting companies. To those occupied in the management of electric lighting properties it does not seem possible that the movement in favor of municipal operation of electric lighting plants, based upon the assumption that a municipality can produce electricity cheaper than, or even as cheap as, a private corporation is well founded. While I do not pretend to claim that electric lighting companies are beyond reproach, I wish to point out that many of the evils complained of as pertaining to corporate management are the direct results of the enforcement of unwise conditions through legislative action.

If reformers will take accurate account of all the points in the problem they will discover that the evils complained of result from errors in legislation designed to determine the relations between municipal bodies and electric lighting companies.

It is supposed by many who discuss municipal affairs that the granting of competitive franchises for public service work is the true means of obtaining for users the lowest possible price for the service rendered, whereas, as a matter of fact, the exact opposite is the ultimate result. This is proved by results in all large cities where the most severe competition has taken place. Acute competition necessarily frightens the investor, and compels corporations to pay a very high price for capital. The competing companies invariably come together, and the interest cost on their product (which is by far the most important part of their cost) is rendered abnormally high, partly owing to duplication of investment and partly to the high price paid for money borrowed during the period of competition. The selling price of a service should be based on its cost, and in any business such as public work, where the investment is large and the annual turn-over is comparatively small, if the item of interest be unnecessarily augmented, it must be reflected in the price paid by public and private users.

While it is not supposed to be popular to speak of exclusive franchises, it should be recognized that the best service at the lowest possible price can only be obtained, certainly in connection with the industry with which we are identified, by exclusive control of a given territory being placed in the hands of one undertaking. In most European countries public service operations enjoy exclusive franchises, under proper control, and are able to obtain capital for their undertakings at the lowest commercial rates, thus materially affecting the cost of their product, of which interest, as I have already stated, is necessarily so great a part. In order to protect the public, exclusive franchises should be coupled with the condition of public control requiring all charges for services fixed by public bodies, to be based on cost, plus a reasonable profit. It will be found that this cost will be reduced in direct proportion to the protection afforded the industry.

Another point that should be included in a proper scheme of public control is a condition under which the municipality would have the right to purchase the undertaking. Such a right should include a direct obligation on the part of the municipality to purchase the property at a fair price whenever it is thought desirable that the industry should be operated by the municipality. The possibility of the exercise of the right of purchase by the municipality would of itself make it to the interest of the owners of the property to do their full duty in their relations to the public. On the other hand, if a community licenses a corporation to perform a certain public service, and if that corporation invests its money and develops its business, surely it is unfair for that community to go into the same line of public service work itself without first purchasing the existing plant.

The subject was next taken up by Mr. Alex. Dow, of Detroit, Mich., in a paper entitled "Public Lighting in Relation to Public Ownership and Operation." Mr. Dow sketched the course of events leading up to the establishment of a municipal street lighting plant at Detroit, showing the futility of attempts at competition in his service, and at the same time the popular demand for it. He believed that had the electric lighting company been more foresighted it would have seen that a municipal plant was inevitable without concessions on its part, and that had concessions, feasible and advisable under the circumstances, been made, the company might have have warded off the building of the city plant. In support of this idea he cited several lake cities where reductions in the prices of street lighting had quieted the agitation for public ownership.

The unwillingness of cities to make lighting contracts of sufficient length to protect the necessary investment, was also pointed out by Mr. Dow. He seemed to think this inconsistent with proposals to issue long-term bonds for municipal plants.

In conclusion, Mr. Dow outlined a future policy in the form of a recommendation "that the association declare by resolution:

(1) A municipality may properly provide for public lighting either by the ownership and operation of an electric lighting plant, by the operation by a contractor under lease of a municipally owned plant, or by contract with the owner of a private plant.

(2) The supply of electric light to private users is not properly a municipal function.

(3) The performance of public lighting under contract by a private plant in connection with the supply of electric light to private users is essentially the method of least expense.

(4) The existence of two electric lighting plants in the same territory is an economic error tending to increase the cost of production, and thereby the selling price; and that the maintenance of competition is to the detriment of the public.

(5) Public lighting by contract should be performed at the lowest price consistent with a reasonable profit on the value of the investment; no electric lighting contractor should demand more than such a profit, and each municipality should protect the contractor in the enjoyment of his profit, and against impairment of his investment, in order that a minimum profit may become reasonable.

(6) In order to adjust prices in the absence of competition it is necessary that costs be ascertained and prices approved by a competent authority, acceptable to the public as well as to the contractor.

(7) In the absence of a constituted authority competent to ascertain costs and prescribe prices, members having public lighting contracts under consideration should endeavor to have the adjustment of the contract price undertaken by a temporary commission, or arbitration committee, who will adopt as the basis of adjustment the principles here set forth.

(8) There is no essential difference in the organization of municipally owned plants requiring a different analysis of costs from that which is proper for private enterprises, and that the publication of the costs of municipal lighting plants properly analyzed is beneficial to the electric lighting industry. Further, the similar publication of the costs of private plants is desirable, but is at present impossible because of its advantages to actual or possible competitors.

In conclusion, I desire to say that the tendency of public opinion appears to be toward some interference by and on behalf of the public with corporations performing so-called public services. Such a tendency is a concomitant of our social progress. It is not merely a temporary surge, but is a part of a general movement. It cannot be withstood, but may be guided into proper channels. The general result of any such movement is for good; the damage which is done to individual rights is incidental and is more often the result of needless opposition by the individual. In this matter of public lighting the right of the community to interfere is so evident that it has been one of the first subjects considered, and will be one of the first disposed of; and its priority in time will establish its disposition as a precedent for the future disposition of similar questions.

This paper called forth some very strong remarks in opposition to municipal interference of any kind, and Mr. H. M. Atkinson, of Atlanta, Ga., presented a written discussion, some extracts from which are given below:

Such an association as this should adopt a platform enunciating its principles on this question, which by its conservatism, temperate tone, fairness, and broadness, will appeal to the taxpayer and intelligent voter. This platform should be carefully prepared, should avoid anything aggressive in its tone, or calculated to excite the opposition of advocates of the policy. We should state that we are opposed to municipal ownership on principle, not alone as owners of electric lighting companies, but as taxpayers ourselves. That after long experience and earnest study, we, as honest business men, believe that private corporate services under proper legislative control, is far better than municipal ownership. We must show that private ownership under proper control means all the advantages of public ownership without any of the risks. We should emphasize the conditions of legislative protection as it exists in France and this country in Massachusetts. We should dwell on the depreciation and losses to which we have been subjected during the past ten years and still are, and should counteract the prevailing idea of great profit, in the business. We should condemn at the start high prices, and the policy of those who exact them.

We should adopt a standard system of accounts for ourselves and advocate the adoption of such a system by every muncipality—one that will appeal to all business men interested or not. We should endeavor to show that cities adopting this policy are providing the soil upon which rings and corruption exist, and without which they cannot. We should counsel fair and accurate expressions of facts and figures on both sides, emphasizing the injustice done by careless, inaccurate, unstudied statements. We should drive home in the minds of the people that a city's only source of income is through taxation or bond issues, which mean taxation perpetuated, and that every dollar raised by the former method is costing them interest as much as the latter. We must urge that cities count cost as fully as private persons. Our fight, in short, is the fight for good and honest government.

We must stand fairly on the platform that we, as taxpayers, as well as owners of electric light works, are opposed to the policy of municipal ownership and operation, as our experience has shown us what it is. We must show how legislative control, requirements, and penalties create a degree of responsibility which never exist as regards a municipal corporation; how elimination of the factor of self-interest is an effective barrier to economy in production or operation on the part of a municipal corporation, and always will be; that private enterprise will always outstrip municipal ownership in filling the gap between supply and demand; that under contract cost is limited to the price, and under municipal cost is not limited.

We should educate public opinion to the unfairness of municipal competition with capital, invited and encouraged to occupy the field, when an industry is an experiment, as long as such capital furnishes good service at a fair price, and that such competition is equivalent to condemnation and confiscation of property without compensation.

BALDWIN TWO-CYLINDER COMPOUND LOCOMOTIVE; NORFOLK & WESTERN RY.

The four-cylinder compound, or Vauclain compound, locomotive, has, during the past few years, come to be so well known as a specialty of the Baldwin Locomotive Works, that it is something of a task to think of that firm as constructing engines of any other type on the compound principle. As general locomotive builders, the firm really has, of course, constructed many compound en-

gines of other types to outside designs, and recently it has completed a two-cylinder compound consolidation locomotive for the Norfolk & Western Ry. after special designs of its own which embody several interesting features. This locomotive is described and illustrated in a pamphlet recently issued by the Baldwin works, and from this pamphlet we have reproduced the accompanying cuts and a portion of the descriptive text accompanying them.

In designing this type of compound locomotive, the essential feature sought was to provide an intercepting and reducing mechanism which would permit the engine to work as a single-expansion engine until such time as the engine driver desired to change it to a compound. This required

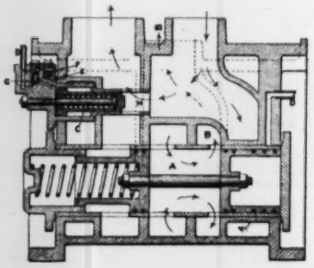


Fig. 1.—Position for Operating Single Expansion.

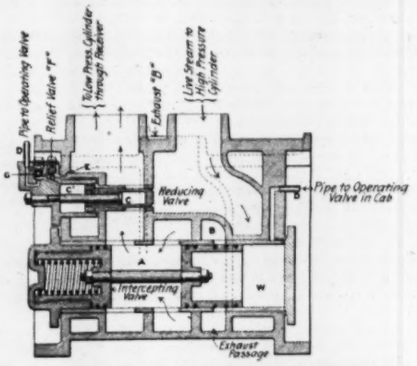


Fig. 2.—Position for Operating Compound.

FIGS. 1 and 2.—LONGITUDINAL SECTIONS OF REDUCING AND INTERCEPTING VALVES OF BALDWIN TWO-CYLINDER COMPOUND LOCOMOTIVE.

the normal condition of the parts employed to be such that the engine would start at any point of the stroke and any position of the cranks. To accomplish this result an intercepting valve, A, is employed, consisting of two pistons connected by a distance-bar or rod, also a reducing valve, C, both of which are placed in the saddle casting of the high-pressure cylinder.

The function of the intercepting valve, A, is to divert the exhaust steam from the high-pressure cylinder, either into the atmosphere, when working single expansion, or into the receiver, when working compound, and is operated at will by the engineer. The function of the reducing valve is to admit live steam at reduced pressure into the receiver when engine is working single expansion, and also to close itself instantly when the intercepting valve is changed to the position which causes the engine to work compound; it being evident that the receiver needs no live steam from the boiler when receiving its supply from the exhaust of the high-pressure cylinder. A further function of the reducing valve is to regulate the pressure in the receiver so that the total pressure upon the pistons of the two cylinders will be equalized. The intercepting and reducing valves are both cylindrical in form, placed in bushings in which suitable ports are cut. The movement of the valves, A and C, in one direction is caused by steam-pressure against the action of suitable coil-springs. These springs cause a return movement when the steam-pressure is withdrawn. These valves are controlled by steam supplied through pipes, D, from the operating valve in the cab.

The reducing valve, C, is operated automatically by the pressure in the receiver when not closed permanently by the steam in the operating pipe, D. For this purpose the port, E, is provided, connecting the receiver with the large end of the reducing-valve piston, under the poppet-valve, F, which remains open as long as the engine is working compound, the poppet-valve, G, being closed by the same pressure, thus preventing its escape to the atmosphere. This pressure, acting on the large end of the reducing-valve, causes it to close the steam passage, H, between the live-steam passage of the high-pressure cylinder and the receiver when the receiver pressure becomes excessive, and vice versa when deficient, the two ends of the reducing-valve being so proportioned that equal cylinder power will be given to both sides of the engine. When the engine is in its normal condition, the lever of the small operating valve in the cab is placed at the position marked "simple," and the engine is then in position to work as a single-expansion engine, the steam-pressure against the intercepting valve and the large end of the reducing valve being relieved, permitting the valves to assume (by the action of the springs), the position shown in Fig. 1. The ports of the intercepting valve, A, stand open to receive the exhaust steam from the high-pressure cylinder and deliver it to the auxiliary exhaust passage, B, and through it to the atmosphere. At the same time the reducing-valve is wide open, connecting the live steam passage, H, with the receiver, through which live steam enters and charges the receiver from which the low-pressure cylinder derives its supply. The receiver-pressure is governed by the automatic action of the reducing valve, previously explained.

Thus the engine can be used as a single-expansion engine to make up trains and start them, and at the will of the engineer the operating valve in cab can be moved to position marked "compound," which will admit steam to the supply pipes, D, thence to the cylinder, W, and cylinder C', changing the intercepting and reducing-valves instantly and noiselessly to position, as shown in Fig. 2, diverting the exhaust from the high-pressure cylinder to the receiver, instead of to the atmosphere, and closing the passage, H, between the live-steam passage and the receiver at the reducing valve. All the parts liable to wear are made of the piston type, depending on packing rings instead of ground joints for prevention of leakage, and at the same time prevent the hammering action so common with valves of the poppet type automatically arranged. At any time the engineer

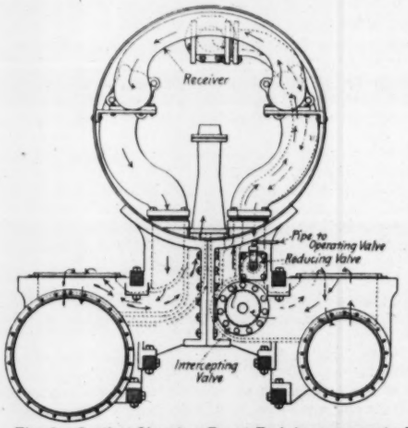


Fig. 3.—Section Showing Front End Arrangement of Baldwin Two-Cylinder Compound Locomotive.

may desire to increase the tractive power of the engine, as, for instance, when the danger of stalling, by moving the lever of the operating valve to position marked "simple," the engine is again changed instantly to a single-expansion engine.

Fig. 3 is a transverse sectional view of the front end of a locomotive, showing the relative location of the cylinders and connections and the [illegible] special constructions just described. The [illegible]owing tabular statement of the principal dimen[illegible]ns of the new Norfolk & Western Ry. engine b[illegible] after this principle will also be of interest in co[illegible]ection with this description:

Table Showing Principal Dimensions of Two-Cyli[illegible] Compound "Consolidation" Locomotive built for t[illegible]orfolk & Western Ry. Co. by the Baldwin Locomoti[illegible]Works.

General Dimensions.	
Cylinders.—Diameter, high pressure	[illegible] ins.
Diameter, low pressure	[illegible] "
Stroke	[illegible] "
Valve	[illegible]ced.
Boiler.—Diameter	[illegible] ins.
Thickness of sheets	11-16-in. [illegible]-in.
Working pressure	[illegible] lbs.
Fuel	[illegible]al.
Firebox.—Material	[illegible]el.
Length	[illegible] ins.
Width	[illegible] "
Depth, front	[illegible] "
Depth, back	[illegible] "
Thickness of sheets, sides	[illegible]-in.
Thickness of sheets, back	[illegible]-in.
Thickness of sheets, crown	[illegible]-in.
Thickness of sheets, tube	[illegible]-in.
Tubes.—Number	306
Diameter	[illegible] ins.
Length	14 ft. [illegible] "
Heating Surface.—Firebox	195.0 [illegible] sq. ft.
Tubes	2593.96 [illegible] "
Total	2788.96 [illegible] "
Grate area	34.8 [illegible] "
Driving Wheels.—Diameter, outside	[illegible] ins.
Diameter of centre	[illegible] "
Journals	8½ ins. × [illegible] "
Engine Truck Wheels.—Diameter	[illegible] ins.
Journals	6 ins. × [illegible] "
Wheelbase.—Driving	15 ft. [illegible] ins.
Total engine	24 " [illegible] "
Total engine and tender	51 " [illegible] "
Weight.—On drivers	Abt 166,000 lbs.
On truck	" 20,000 "
Total engine	" 186,000 "
Total engine and tender	" 266,000 "
Tender.—Tender wheels, diameter	[illegible] ins.
Journals	4¼ ins. × [illegible] "
Tank capacity	4,000 gals.
Weight, empty	Abt 31,700 lbs.
Service.—Freight; guaranteed to develop tractive power up to the limit of adhesion, while working at full stroke on a grade of 2.2%.	

A LARGE ROCK-CRUSHER AND CRUSHING PLANT.

Many of our readers will remember at the Columbian Exposition a monster Gates rock crusher of 150 tons capacity per hour, driven by an engine of 125 HP. This machine was described and illustrated in our issue of Feb. 9, 1893. The enormous scale on which rock is now quarried and broken is illustrated by the fact that the Gates Iron Works, of Chicago, the builders of the crusher, have put upon the market a still larger machine, with a capacity of 200 tons per hour, or 2,000 tons (say 67 car loads of 30 tons each) per working day. About 40 of these large machines are now in use, the majority of them being employed in breaking up limestone for blast furnaces, the smaller material taken out by the screens being used for ballasting, or road making.

In appearance and internal construction the 200-ton machine does not differ materially from the 150-ton machine already illustrated in these columns, except by its larger size. It stands 10 ft. 11½ ins. high from base plate to the top of the hopper, the width of the base plate being 9 ft. 11 ins., and the diameter of the hopper 11 ft. The cross frame which supports the head of the vertical gyrating crusher head divides the hopper into three receiving openings, 18 × 42 ins. The driving pulley is 48 ins. diameter, and is driven at 350 revolutions per minute by means of an engine of 150 HP. This gives a speed of about 140 gyrations per minute to the crusher head. This head is of cast-iron, 40 ins. high, 22 ins. diameter at top and 38 ins. at bottom. The conical crushing chamber is 36 ins. deep, 56 ins. diameter at the top, and 41 ins. at the bottom. The large end of the head is slightly below the small end of the chamber, so that the size of opening between the head and chamber (which governs the size of output) can be varied by raising or lowering the head. This is done by means of a screw in the foot-step bearing of the crushing shaft. The eccentrical throw of the gyrating crusher head is 2 ins. The crusher head and the lining plates of the chamber are usually of hard cast-iron, though cast-steel is used in machines shipped to distant points, where the cost of freight on new plates or heads for renewal would more than balance the extra first cost for the more durable steel. The total weight of the machine is about 90,000 lbs.

One of the machines has been in use for nearly two years at the quarries of the Pittsburg Lime-

stone Co., Newcastle, Pa., and we give below an abstract of a letter from Mr. Geo. W. Johnson, President of that company, to the Gates Iron Works, containing a record of 14 months' work. The record gives the number of cars, and to this we have added the gross tonnage in each case:

Concerning the working of the Gates No. 8 crusher at our mines at Franklin Forge, Pa., we would say that in the 14 months from July 1, 1896, to Aug. 31, 1897, there were crushed 23,174 cars of limestone averaging 24 gross tons (of 2,240 lbs.) each, as per the following statement:

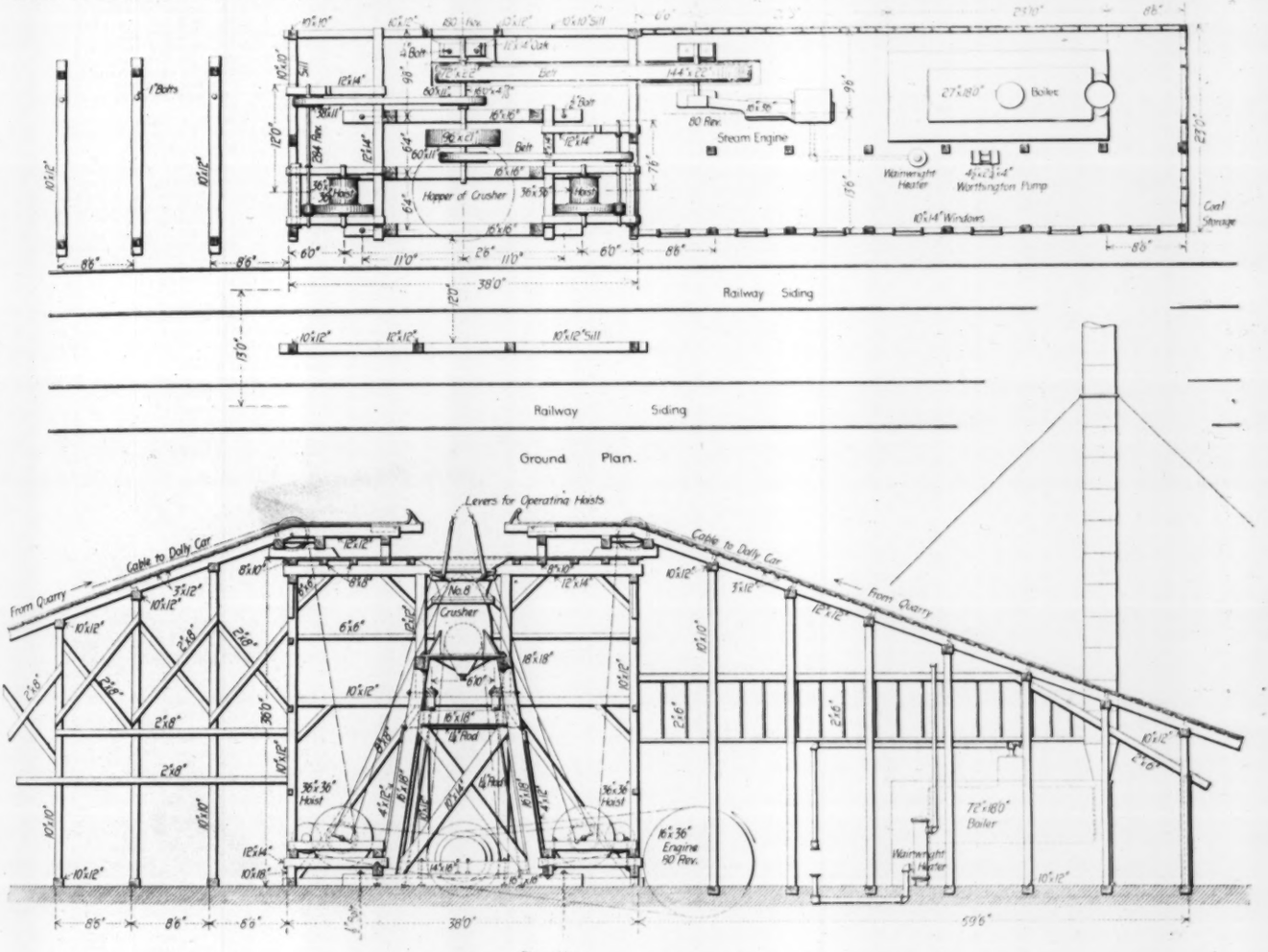
1896.	Cars.	Tons.	1896.	Cars.	Tons.
July	1,270	30,480	Feb	1,341	32,184
Aug	1,474	35,376	March	1,775	42,600
Sept	1,337	32,088	April	1,738	41,712
Oct	1,819	43,656	May	1,710	41,040
Nov	1,612	38,688	June	1,974	47,376
Dec	1,789	42,936	July	1,871	44,904
Jan., '97	1,486	35,664	Aug	1,978	47,472
Total in 14 months		23,174			556,176

The amount paid for repairs to September, 1897, is $597.14.

The above records of daily work have since been exceeded, and Mr. J. W. Lewis, Superintendent, states that on March 15, 91 cars of limestone were crushed in 10 hours; 50 cars were of 60,000 lbs. capacity, and the total amount was 2,250 gross tons, or 225 gross tons per hour.

With a machine of this size and capacity the system of handling the material from the quarry to the crusher must be carefully planned in order to insure that the machine is kept supplied, but for the machine whose record is given above no special arrangements were made to expedite the handling of such an enormous tonnage. The crusher is placed at such a height above the railway track that the crushed rock output runs over an inclined screen from which it is discharged directly into the cars. The ledge from which the rock is quarried is above the crusher, and has a face about half a mile in length, running parallel with the shipping tracks. The rock blasted from the ledge is loaded into iron dump cars of 3 cu. yds. capacity, which run by gravity on a track of 36 ins. gage to the scale house, which is about 50 or 60 ft. from the crusher. From the scale house to the crusher the track has a very slight down grade. At the end of this track, over the crusher, is located a tipple which automatically dumps the cars. The empty cars are pushed back by hand onto a return track, and are hauled to the quarry by horses.

In this case the movement of the load is all down grade, but the accompanying cut shows the arrangement of another crushing plant of the same capacity at the same company's quarries at Newcastle, Pa., in which the stone has to be raised to the hopper of the crusher. The rock is hauled up from the quarry level in dump cars on two inclined planes, one on each side of the crusher, by means of two belt-driven hoists. The cable, however, is not attached to the car, but to a small dolly car (called a "go-devil" by the quarrymen) which runs on a narrow gage track in the center of the track of the dump car, the former extending into a pit at the foot of the incline. The loaded car from the quarry runs over this pit, and the hoisting engine then hauls up the dolly-car, which pushes the dump car in front of it. On the return, the two cars run down by gravity, and as the dolly-car disappears in its pit the dump car runs for a considerable distance into the quarry by its own momentum. The hoists are controlled by the levers shown on the platform at the head of the incline. The crushed stone is delivered by spouts directly from the crusher to railway cars standing on a track in front of the plant, as shown. The plant is enclosed in a substantial frame building, the sills of which are bedded in cement mortar. The foundation bolts are either corrugated or split and wedged open at the ends, and these bolts are let into the rock and secured by cement grouting.



ROCK-CRUSHING PLANT AT THE QUARRIES OF THE PITTSBURG LIMESTONE CO., AT NEWCASTLE, PA.
Built by the Gates Iron Works, Chicago, Ill.

The following are some of the dates of extra big work:

Dec. 15, 1896, crushed 80 cars (2,794 tons) in 10 hours, namely:

41 cars of 60,000 lbs.	1,982 tons
26 cars of 50,000 lbs.	581 "
13 cars of 40,000 lbs	232 "

April 12, 1897, crushed 81 cars (1,875 tons) in 10 hours:

36 cars of 60,000 lbs.	964 tons
24 cars of 50,000 lbs.	536 "
21 cars of 40,000 lbs	375 "

Jan. 18, 1897, crushed 85 cars (1,920 tons) in 10 hours:

36 cars of 60,000 lbs	964 tons
18 cars of 50,000 lbs.	402 "
31 cars of 40,000 lbs.	554 "

June 21, 1897, crushed 86 cars (1,942 tons) in 10 hours:

36 cars of 60,000 lbs.	964 tons
19 cars of 50,000 lbs.	424 "
31 cars of 40,000 lbs.	554 "

During this time the crusher was off for repairs as follows:

	Time off.
1. Shaft out and sent to foundry for repairs	3 days
2. Shaft taken out and new one put in	11 days
3. Hopper broke, repaired at night	none
4. New hopper put in at night	none
Total	14 days

THE LIVERPOOL MOTOR WAGON TRIALS.

The Self-propelled Traffic Association, of Liverpool, England, some time ago arranged to have a trial of motor vehicles adapted to hauling heavy loads, and the competition has taken place; has been reported partially both by "Engineering" and "The Engineer," and from these journals we make the following abstract:

There were six entries for the three prizes offered, of £100, £75 and £50. Two of the vehicles entered failed to appear. The other four carriages were made by the following firms: Steam Carriage & Wagon Co., of Chiswick; Liquid Fuel & Engineering Co., of East Cowes, Isle of Wight; and the Lancashire Steam Motor Co. The trial was to extend over four days, the motors running at fair speed over the ordinary undulating country roads.

The motor, or steam wagon, built by the Lancashire Steam Motor Co., is designed to carry four tons. It has a steel frame and an open platform of 78 sq. ft., carried on four wheels, and the driving pair about under the center of the load platform. It is fitted with hinged side and tail boards and two powerful brakes are included, claimed to be capable of stopping the wagon in half its length and holding it on an incline of 1 on 7. The upright fire-tube boiler, at one end, has 110 sq. ft. of grate surface, and is arranged to work at 200 lbs. steam pressure. Liquid fuel is used, with the supply regulated by the boiler pressure, making the firing automatic. Water is fed to the boiler by a small brass feed pump, with a constant feed, and a condenser is located on the roof of the cab. When working at full capacity 1¾ gallons of oil per hour are consumed.

The Steam Carriage & Wagon Co. submitted two vehicles, a 5-ton lurry and a 2-ton wagon. The first is intended for a speed of 5 miles per hour and is six-wheeled and articulated, with two sets of wheels under the cab and forward-pivot, and one set under the rear of the load platform. The available floor space is 110 sq. ft., and the dead weight is 3 tons 19½ cwt. light, and 4 tons 5 cwt. with fuel and water. The under frame and wheels are made of steel, and the latter have roller-bearings. The boiler is a special Thornycroft water-tube boiler, arranged so that the tubes may be easily cleaned inside and outside, and the heating surface is 65 sq. ft., with a grate area of 2½ sq. ft., and a working pressure of 175 lbs. A blower, which furnishes forced draft, is driven by the engine, or by hand in firing up. The engine is of the horizontal compound type, with 4 and 7-in. cylinders and 5-in. stroke; and this engine is entirely enclosed in a dust-tight casing, with the moving parts running in an oil bath. The gearing is arranged at two speeds, of 9 or 12 revolutions to one of the driving wheels, so that the engine may be run free, if desired. A powerful screw-down hand-brake is fitted to the tires of the driving-wheels, and an independent steam-brake, acting with a maximum pressure of 2¼ tons, operates upon the trailing wheels. The smaller wagon made by the same firm is built upon similar lines, with only four wheels and no pivot. It is designed to carry 2½ tons, and the steam pressure is 175 lbs.

The 2-ton steam lurry built by the Liquid Fuel Engineering Co. is 16 ft. 2 ins. long by 6 ft. 6 ins. wide over the hubs. The platform is 10 ft. long by 6 ft. 5 ins. wide, and has 64 sq. ft. of available space. The frame is made of a mild steel channel, bent to shape and riveted with steel gusset plates; the wheels have bronze hubs, with a large lubricating reservoir, oak spokes, ash felloes and 3-in. steel tire. The steering is accomplished by means of a handle connected to pivoted axles. The 25-HP. engine is of the compound, reversible type, and the working parts run in dust-proof oil cases; the engine speed is 600 revolutions for a speed of 8 miles per hour, and it is geared down from 8 to 1. There is a water-tube boiler, bolted to a steel frame forward, and having 80 sq. ft. of heating surface. Power is transmitted to the driving shaft by steel cut bevel gears running in dust-proof oil eases, and the rate of speed is regulated by the amount of steam pressure; high pressure steam being let into the low pressure cylinder, when extra power is wanted. The reversal of the engine acts as a powerful brake; but an emergency brake, operated by the foot, also acts directly upon the rear wheels. Two oil-tanks, of 20 gallons each, are placed at the rear of the wagon, under the platform; and two 16-gallon water tanks are under the driver's seat, and a 75-gallon tank is underneath the platform. The light dead weight of the lurry is 38½ cwt.; and with fuel and water, 54 cwt.

The first part only of the trial is reported. The route was 35 miles long, and the first to start was the 5-ton lurry of the Steam Carriage & Wagon Co., followed by the others, all fully loaded, as indicated. The wooden wheels of the Lancashire wagon gave way by the tires becoming loose, when about half the circuit was made, and the same thing happened to the steel wheels of the 5-ton lurry. A tube in the boiler of the 2½-ton wagon of the Steam Carriage Co. burst from being stopped up, and the 2-ton car of the Liquid Fuel Co. had hot boxes; but the latter vehicle kept on and was the only one of the four vehicles that made the entire circuit.

The Liquid Fuel Co.'s wagon consumed 20 gallons of oil in the 5 h. 27 m. required for going the 35 miles; excluding stoppages, the net time was 4 h. 56 m. The 2½-ton Chiswick wagon made the distance in 6 h. 35 m., excluding stoppages, but was delayed 4 hours repairing the boiler; it consumed 384 lbs. of coal. The 5-ton Chiswick lurry got in very late, owing to the tire coming off, and the Lancashire wagon, after making repairs to its wheels, returned home.

The roads of this district, says "Engineering," are extremely trying for heavy loads, as the native stone "sets" wear unevenly, and the roads are not kept in good repair. But the same authority regards the competition encouraging, so far as it had gone at that time. The wheel problem seems to be the chief difficulty; and as this trouble has been met by traction-engine builders, the heavy-load motor-builders would do well to study the question from the standpoint of traction-engine experience and practice.

AN IMPROVISED GASOLINE MOTOR CAR.

The accompanying illustration represents a type of motor car upon which there are no "complicated patents," and a type which can, therefore, be reproduced without fear of infringing and at small expense. We are indebted to Mr. John A. Laird, Mechanical Engineer of the Construction Dept. of the St. Louis Water-Works, for the photograph and the accompanying descriptive letter:

HAND-CAR OPERATED BY A 2-H.P. GASOLINE MOTOR.

Sir: I enclose a photograph of a 2-HP. Willard Launch gasoline engine, manufactured by Chas. P. Willard, Chicago, Ill., applied to an ordinary hand car, which has given very good satisfaction in carrying men, tools, etc., a distance of 5 miles over the water-works switch from Baden to the Chain of Rocks.

It is run in all kinds of weather, making the trip easily in 15 minutes, carrying 8 to 10 men, on one quart of gasoline. This makes 20 miles to a gallon, costing 7 cts., or say ½ of a ct. per car mile. It has carried as many as 17 men. As may be seen, the engine is connected to the car by a belt, and it is started in either direction by merely pushing the car a short distance. The car, with complete equipment, weighs 1,140 lbs., and can be taken off or put on the track with comparative ease by two men.

It has given such good satisfaction on our work, that it occurred to the writer that a similar combination might be used for an inspection car by roadmasters or other officials who have occasion to inspect track, etc. It seems to possess many advantages over the inspection car provided with boiler and engine. Five gallons of gasoline, weighing less than 40 lbs., will run 100 miles. There is very little heat, no odor, it is not necessary to have a skilled engineer to run it, nor to run on orders, any more than with an ordinary hand car. It can easily keep up a speed of 20 miles per hour and there is no necessity of hunting up coal chutes or water tanks. Finally the cost must be materially less than that of the steam car.

ANNUAL MEETING OF THE NATIONAL FIRE PROTECTION ASSOCIATION.

The annual meeting of this society was held in Chicago, June 7, 8 and 9, at the rooms of the Chicago Underwriters' Association. Representatives of the following organizations were present: New York Board of Fire Underwriters, South Eastern Tariff Association, Boston Board of Fire Underwriters, Philadelphia Fire Underwriters' Association, Insurance Association of Providence, Middle States Inspection Bureau, Western Factory Insurance Association, Union Underwriters' Bureau of New England, Chicago Underwriters' Association, Factory Insurance Association, New England Insurance Exchange, St. Louis Board of Underwriters, Canadian Fire Underwriters' Association.

The President, Mr. U. C. Crosby, delivered an address, in which, among other things, he said:

The objects of this Association are to promote the science and improve the methods of fire underwriting and to obtain and circulate information on this subject. As stated at our last annual meeting, this Association was brought into being by a call for a conference by different bureaus and organizations having to do with automatic sprinkler protection, there being a general demand for more uniform rules on this subject. These conferences brought out clearly the value of mutual consideration, by representatives from different sections of the country, of other numerous questions involved in the general subject of fire protection.

In the poor construction of buildings lies the very foundation of our trouble, and is to be found the direct cause of most large fires and conflagrations. If one defect alone—open communications between floors in mercantile and manufacturing buildings—could be eliminated the loss ratio would be very greatly reduced. If you will consider the conditions connected with most large fires you will note that the rapid spread of fire was promoted or accelerated by open light or elevator shafts, or other vertical openings, also that badly arranged flues, poorly located heating apparatus, concealed spaces and many other evils are frequently developed in event of fire which could have been easily prevented, many of them at little or no expense to the owner if taken into consideration by the architect in making his plans and specifications before the construction of the building. The question of proper protection against fire seems rarely to be considered by the architect. Practically all buildings, excepting a few isolated special hazard risks and new structures within the fire districts of large cities having serviceable building laws, contain a few or many vital structural defects.

I do not refer simply to monuments of the past, but include structures now in process of erection.

The Secretary, Mr. E. U. Crosby, then presented a report, which was devoted largely to the action of sprinklers in fires. We quote the following extract:

Sprinkler fires have been reported during the year on the blanks furnished. In all, 201, as against 205 the year previous. The action of sprinklers is regarded as satisfactory in 191 instances and unsuccessful in 9.

Many interesting incidents are noted, as:

A remarkable sprinkler achievement. A fire at Northwestern Cordage Company's plant, St. Paul, Minn., was caused by a hot bearing and flame was instantly blown throughout the various rooms by hot-air blower system, fire feeding on particles of lint floating in the room or lodged within blower pipes. Two hundred sprinklers opened, which extinguished the fire.

"Fire occurred among chair stock piled within six inches of sprinklers under open joist ceiling. Seventy-four heads opened, sixteen of which sprayed on the fire, holding it properly in check."

"Fire in show window of department store where water was shut off sprinklers owing to cold weather, resulted in opening thirteen heads in store proper, which accomplished a heavy water damage."

"Needless water damage coused by those responsible for shutting sprinkler valves after fire. Fifteen minutes wasted in trying to find valves."

"When starting fire pump for test fire was caused by sparks from friction gear igniting lint on main pulley and on main shaft."

"Poorly located valve caused loss of time in shutting off sprinklers, and consequently unnecessary water damage."

Watchman failed to give alarm in three cases, sprinkler alarm failed twice, thermostats once.

Summary of Fires.

For the Association years ending 1897 and 1898, classified separately and together. Total number of fires reported 1897, 205; 1898, 201. Total, 406.

	Times reported.			P. C. of whole.		
	'97.	'98.	'97-8.	'97.	'98.	'97-8
Time of day:						
6 a. m. to 6 p. m	77	113	190	38	56	47
6 p. m. to 6 a. m	85	82	167	41	41	41
No data	43	6	49	21	3	12
How discovered:						
Workmen	62	97	159	30	48	39
Sprinkler alarm	17	51	68	8	25	17
Watchman	30	29	59	15	14	14
Persons outside property.	16	14	30	8	7	8
Thermostats	21	7	28	10	3	7
No data	59	3	62	29	1	15

Effect of Sprinklers.

	Times reported.		
	1897.	1898.	1897-8
Practically extinguished fire	101	137	238
Held fire in check	75	47	122
Satisfactory	18	7	25
Total successful	194	191	385
Unsuccessful	10	9	19
No data	1	1	2
	205	201	406

C. A. Hexamer, of Philadelphia, submitted the report of the Committee on Wire Glass. The experimental work was still in progress, the report said, and time for further investigation was requested and granted.

Mr. Griswold read a paper on "Acetylene Gas," in which he called attention to its destructive properties, and said the danger lay in the numerous generators invented by men who knew nothing of its chemical properties, and hence the devices were ill-adapted for use. A long discussion followed relative to acteylene gas generators resulting in a unanimous expression of opinion that they should be located outside the building in which the lights were used.

"Chemical Fire Extinguishers" was the title of a paper then presented by Mr. Hexamer. The following is an extract:

While hundreds of compounds and devices have been "invented" (?), few, if any, have succeeded in demonstrating their value, and of obtaining a foothold among the fire extinguishing apparatus of our fire departments. The "inventor" of fire-extinguishing powders or solutions is restricted to compounding mixtures from the following list of chemicals, whose properties are well known, viz.: Alum, soda, borax, hyposulphite of soda, silicate of soda (water glass), chloride of lime, tungstate of soda, chloride of tin, sulphate of ammonia, chloride of ammonia, sulphate of soda, nitrate of soda, chloride of sodium (common salt), potash, bicarbonate of soda and ammonia. The process of inventing a chemical fire-extinguishing compound is, therefore, the question of a short time. As an example of this class of chemical fire extinguisher, I will ask you to recall the advent of the "hand grenade." The millennium had arrived; no more conflagrations were possible. Fire tests such as described further on, were made in every city and village; thousands of glass bottles, filled with an inexpensive saline solution were sold at many times their value; the papers were full of cases of fires extinguished by hand grenades, etc., etc. The claim that a substance had at last been found, which, thrown into a fire at its incipiency, generated a gas and promptly extinguished the flames, seemed to be substantiated. The burning of a warehouse containing a large number of hand grenades on storage in this city, however, demonstrated very forcibly that the extinguishing gas supposed to be generated by heat, did not generate.

The only chemical fire extinguisher which has won a permanent place among the apparatus used by organized fire fighters throughout the world is the carbonic acid gas extinguisher. It consists of a cylinder, usually of copper, which, as the pressure of the gas generated therein reaches about 125 lbs. per sq. in., and which under certain conditions may largely exceed this, for safety must be strong enough to stand from 300 to 500 lbs. The cylinder is closed by a screw cap, and provided with an outlet to which a short piece of hose is attached. A short metal nozzle, usually of lead or an alloy of lead, is attached to the hose. A stop-cock to shut off the chemical fluid may, or may not, be used. The chemicals used are bicarbonate of soda dissolved in water of sufficient quantity to fill the cylinder, and sulphuric acid, which latter is contained in a glass bottle inside the machine, so arranged that when to be used, the bottle is either reversed or broken, discharging the acid into the soda solution, generating carbonic acid gas.

The various extinguishers now in use differ principally in the method of storing the sulphuric acid, and in the method of mixing the acid with the soda solution. Both the soda solution and carbonic acid gas are of value as extinguishing agents, although I believe that except in cases of very close application to the fire, or in confined spaces, the carbonic acid gas is valuable more as a propelling agent for the soda solution than as an extinguishing agent.

The proportions of the chemicals are so arranged that the amount of bicarbonate of soda is largely in excess of the amount necessary to take up the quantity of sulphuric acid used.

As carbonic acid gas acts solely by exclusion of the air necessary to support flame, and as the proportion of carbonic acid gas necessary to render the air in a certain space a non-supporter of flame, is about ten per cent., in large open rooms, or in the open air where confining the gases is impossible, carbonic acid gas—except in exceedingly large quantities—is of little avail. The value of the carbonic acid gas extinguisher depends largely on the fact that the soda salts are very soluble, and that a saturated solution, when thrown on the fire, at once coats the burning substance with a crust of incombustible soda salts, thereby preventing the spread of the fire. It is due to this fact that chemical fire buckets, syringes, and the tin tube extinguishers, have in some cases been of value, as a soda solution of some kind is usually the chemical this class of extinguishers contain.

Returning to the question of extinguishing fires by means of gases generated from chemicals thrown into the flames, I am of the opinion that this claim is largely due to the fact that so-called fire tests of fire extinguishers are generally arranged to prove this claim. You are all familiar with the stereotyped test of this kind; a large wooden box carefully placed with reference to the direction of the wind at time of test, is partly filled with strips of wood, excelsior and other inflammable material, treated to a liberal allowance of coal oil, turpentine or tar. The application of the liquid from the extinguisher being tested is made to the base of the burning mass, apparently that the gas generated from the chemicals may rise and extinguish the flame. Some gas, if the heat is great, is undoubtedly liberated and has some effect on the flames. The fire, however, is usually extinguished by the coating of the burning substance with a soda salt, thereby preventing the generation of combustible gases.

It is found in such tests that the oil used, after having the desired effect of creating a very large and fierce flame, has been entirely consumed. I recall a test of a chemical extinguisher where the regulation test was made as follows: A large piano box with one side removed and set on edge was partly filled with strips of wood and excelsior, liberally treated with coal oil, the upper portion of the box was painted with a tarry mixture; when ignited, the flame shot up twenty feet or more; with one application of the extinguisher, the flame was extinguished. The oil and tarry paint having been entirely consumed and the wood only slightly charred.

In order to show the value of the extinguisher being tested, the inspector of the local underwriters' association present arranged a test as follows: A wooden box constructed to resemble a wardrobe in a dwelling, but without doors, was filled with old clothing—both cotton and woolen—suspended from a shelf, additional clothing being piled on the shelf. No oil or other inflammable matter being used. When the clothing was ignited and the fire well under way, the expert of the extinguishing company present was directed to attack the fire. About a dozen extinguishers were used at very close quarters without having a very decided effect on the fire, which was not extinguished until the clothing had been consumed. While one extinguisher was sufficient to extinguish a fire with flame nearly twenty feet high, the attempt to extinguish burning clothing in the open air where it was possible to fight the fire at close quarters proved a failure. It has been claimed by some that ordinarily a fire extinguisher containing chemicals in solution is valuable only to the extent of the water contained therein. A recent test of a chemical attachment to fire buckets seems to substantiate this claim.

In all large cities where carbonic acid gas extinguishers are a part of the regular equipment of the fire department, either as portable extinguishers in connection with patrol wagon or hook and ladder companies, or as chemical engines, the results achieved are very gratifying. In Philadelphia during the years 1896 and 1897, fully 25% of all fires were extinguished by chemicals alone without use of water. In this city the percentage is even larger. In suburban towns, villages, and isolated country properties, a chemical extinguisher, either portable or on wheels, is of greater value than all other apparatus. In answer to queries sent to chiefs of fire departments throughout the United States, it is shown that in various cities from 25% to 80% of all fires were extinguished by carbonic acid gas without the use of water.

What to consider a satisfactory fire test of a chemical extinguisher is difficult to decide. The question of preparing a specification for a standard chemical fire extinguisher is one well worth a special committee of this association: Suffice it to say that in my estimation such an apparatus must be a carbonic gas extinguisher.

The president was empowered to appoint three members as a special committee to prepare specifications for a standard chemical fire extinguisher.

F. E. Cabot, of Boston, presented the report of the Committee on "Thermoelectric Fire Alarm Regulations," which he said had been prepared with the co-operation of committees of various institutions. A set of rules was proposed for the installation of firing and apparatus for automatic devices. The discussion of this subject hinged upon the area of ten feet proposed for thermostats, which, it was believed, would cause unnecessary expense in changing systems already installed. Wm. A. Anderson, of New York, said that he had signed the report, protesting against that portion of it. The matter was finally referred for the further attention of the committee.

A paper on "Steel Rolling Doors," by Mr. F. C. Biggert, was read by the secretary. The following is an extract:

We have given frequent opportunities for the installation of the roll shutter, but find little response on the part of the owners. We think the shutter very desirable in locations where, for any reason, the ordinary fire shutter can not be used, and it goes without argument that for the protection of fronts, where the somewhat unsightly standard shutter is objectionable on account of appearance, the roll shutter fully meets the requirements. In narrow areas, or where windows are so closely placed as to allow insufficient space for swing or slide, or between fire escapes and the walls of the building requiring protection, the roll shutter is probably the best practical substitute for what I think we all agree to be the best protection—the standard shutter. We cannot secure the same degree of safety through the use of these shutters that is given by the wood-filled tin-covered standard. It is not to be supposed that the naked steel, even if used on both sides of openings, will give the same resistance as the tin-clad door, re-enforced—if the expression may be used—by the wood filling, and admitting this view of the case we can only regard the roll shutter as probably the best substitute for the standard shutter, where it is impossible or undesirable to use the latter.

Summing the matter up, it stands thus: For front or rear openings, exposed across narrow streets or alleys, the steel rolling shutter or door is desirable and unobjectionable. For any opening where the usual standard shutter or door cannot be used, it is probably next best, dividing the honors with the wire glass; but in any case where the standard can be used, it is best to discourage the use of any substitute.

The standard tin-clad fireproof doors, specified by the Philadelphia Underwriters' Association, in 1889, were thus described in the report of the committee on "Tin-Clad Fire Door and Shutter:"

Wood to be well seasoned white pine boards not exceeding 4½ ins. wide; asbestos paper to be placed between boards, one side of the door to be vertically and the other diagonally boarded. Old-fashioned wrought-iron clinch nails are to be used; screws are forbidden. All edges are planed and carefully squared, both sides and edges of the door are to be covered with I. C., 14 by 20-in. sheet charcoal tin; work to commence at corners and edges. The doors should close automatically, when possible, and preferably by sliding. The wrought-iron angle rail, ⅝ × 1⅝ ins., should rest on wrought-iron lugs built in the wall and bolted by ⅝-in. bolts. The rails are set at an incline of ⅜-in. to the foot. A stone sill, and on top a brick arch in place of an iron girder, are preferable. A weak point to be especially guarded against is found in the manner of locking the tin sheet.

The fire-door frame of the Boston Board of Fire Underwriters was described by Mr. F. E. Cabot as follows:

Two angle irons, 3 × 3 ins., make the sides of the frame and these are fastened to an angle iron or plate at the top and sill. These irons are bolted through the wall by three or four bolts; and the brickwork is usually cut out so as to allow the boltheads to set back of the wall surface, and this opening is later filled smooth with plaster. The iron sill rests directly on the brickwork and is set in cement, with the edge extending an inch or two beyond the outer surface of the door and level with the floor. On the inner part of the angle-iron frame, on both sides and top, is riveted a piece of iron 1 in. wide by ¼-in. thick; this makes a rabbet against which the door shuts tightly and evenly. To the outer faces of the angles are riveted the hinges and latch-fastenings, all of wrought iron. When the door protects one side only, the details are the same, except that the angle irons are on one side of the wall only.

A discussion followed as to the merits of iron doors, tin-clad doors, rolling doors, and the iron frame for fire doors.

Officers for the ensuing year were elected as follows: President, U. C. Crosby, Boston, Mass.; Vice-President, C. A. Hexamer, Philadelphia, Pa.; Secretary and Treasurer, E. U. Crosby, Underwriters' Bureau of New England, Boston, Mass.

ANNUAL CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The twenty-first convention of this association was held at the Auditorium Hotel, Chicago, Ill., June 7, 8 and 9. The first meeting was called to order about 11 a. m. June 7, and the President, Mr. Samuel Insull, delivered the opening address, some extracts from which, dealing with municipal ownership of electric lighting plants, are given in another column. Mr. Insull devoted a large part of his address to the question of using standard or special machinery, and strongly advocated the use of the manufacturer's standards. As he made no reference to the other side of the question, however, his discussion of the subject was not so thorough as that presented in the paper on "The Relation Between the Purchaser, the Engineer and the Manufacturer," by Mr. W. H. Bryan, read at the June meeting of the American Society of Mechanical Engineers (Eng. News, June 2, 1898). As to municipal ownership of electric lighting plants, Mr. Insull did not consider that the conditions of municipal government in this country promised greater economy for municipal plants than for corporate plants.

A paper on "Analysis of the Cost of the Generation and Distribution of a Unit of Electricity" was then read by Mr. Calvin W. Rice, which was largely a compilation of tabulated statistics and records published within the past few years. His figure of 575 gross watt-hours per lb. of coal at the electric light station at Budapest was objected to by some speakers as being far too high, but other speakers thought this might be accounted for by the use of a high grade of coal at that station. The following are some extracts from this paper:

In America the variation in the investment per kilowatt is $200 to $750 per kilowatt capacity installed. In a few cases the figure is below $200, and in a few as high as $1,000; but in the great majority of cases the cost is below $400. In this respect American practice is ahead of that of Great Britain and the Continent, where the majority of plants have a total investment of over $500 per kilowatt installed.

Later in this paper are given figures on some railway plants in Chicago costing less than $75 per kilowatt. I think these figures refer to stations alone, whereas the corresponding values for lighting plants include distributing systems also.

The importance of keeping down the investment per kilowatt need not be emphasized. The principal items that go to make up the total investment are real estate, steam or water power plant, electric plant distributing system and minor details.

In the first item we naturally find a great variation in the different plants. In country towns it runs as low as $25 per kilowatt, and in cities as high as $150 and over. In other words, there are some plants where the investment in real estate alone is greater per kilowatt than the entire investment is in others. The investment in steam plant varies from $20 to $60, with figures on the electric plant slightly greater.

Great stress is nowdays put upon high efficiency, and while this is important, reliability should be the principal feature. In the present day of good design there is at best little to be gained in absolute efficiency but the cost of energy, and the popularity of electric light and power will be very much affected, according as it is reliable. Good regulation in the station is more important than high efficiency. Good regulation in the station means ability to use high efficiency lamps.

The use of 50-watt instead of 58-watt lamps means a saving of 14% directly in the lamps and in the copper losses. Relatively this increase in efficiency is much greater than is possible in any of the various types of boilers, engines or generators. Therefore the governing of the engine from no load to full load, and the regulation of the generators with load thrown off and on, should be carefully determined.

As the total cost of plant per kilowatt has been found on the average to be under $400, calculations as to cost of operation of plant per unit output per year gives that figure to be, on the average, under 50 cts.—that is, it requires 50 cts. worth of plant to generate and distribute one kilowatt hour per year.

A discussion on the topic of "Prices and Discounts for

Electric Current, and Methods of Billing Current to Customers" was then taken up, and followed largely upon statements made by Mr. Insull and Mr. Rice. The former took part in the discussion and described the system used by his company (the Chicago Edison Co.), and referred to its very extensive application of the "Wright demand" meter, which shows exactly the maximum consumption of the consumer. Mr. Alex. Dow, of Detroit, stated that he could not afford to use such recording meters for all customers, and therefore applies them temporarily and makes yearly contracts on the result of the readings. Mr. Ferguson, of the Chicago Edison Co., thought that such a method was probably less economical, on account of consuming much valuable time, than it would be to raise money to put in these recording meters permanently. The discussion turned very largely on the classification of consumers, and the regulation of prices for these various classes.

At the afternoon session, Mr. Alex. Dow read a paper on "Public Lighting in Relation to Public Ownership and Operation," an abstract of which we publish elsewhere. Mr. Dow thinks that there is a general and irresistible tendency towards interference by and on behalf of the public with corporations performing public services. The general result of such a movement is good, but he does not consider that the supply of electric light to private consumers is a municipal function. The discussion was taken up by several members, including Mr. Scovil, of Cleveland, and Mr. Atkinson, of Atlanta, Ga., all of whom strongly opposed municipal ownership on principle, and also opposed municipal operation of any enterprise of this kind. Mr. Atkinson thought that the association should undertake to educate public opinion as to the unfairness of municipal competition with private capital and should undertake to show that private corporate service under proper legislative control is far better than municipal ownership. Some extracts from his remarks are given elsewhere in connection with the remarks by Mr. Insull and Mr. Dow on the same subject.

The morning session on June 8 was devoted to the consideration of the relative merits of the alternating and direct current systems of distribution. The first paper was by Mr. Herbert A. Wagner, of St. Louis on "General Distribution from Central Stations by Alternating Currents," in which this system was advocated, and more particularly a special application in which the alternating current is applied to the feeders at high potential and transformed down for the mains. This was followed by a paper on "General iDstribution from Central Stations by Direct Currents," by Mr. Louis A. Ferguson. This paper described the direct-current system of the Chicago Edison Co., and presented the general advantages of this system, as well as the special advantages for electric elevator service, and the advantages to be secured by the addition of a storage battery. Mr. Ferguson thought that the successful central station company of the future would employ the direct current for distribution in thickly settled districts and the alternating current for distribution in the more scattered districts and the suburbs. We publish abstracts of both these papers separately.

The trend of the discussion was mainly adverse to the alternating system, both from the technical and financial points of view, though one member spoke in its favor for power purposes, and expressed the opinion that alternating-current single-phase motors will soon be made superior to direct-current motors. Mr. Ayer did not approve of a combination system as suggested by Mr. Ferguson, but considered that for business reasons it would be better to have but one kind of plant. Mr. Insull, President of the Association and of the Chicago Edison Co., spoke very strongly in favor of the direct-current system from a business point of view and in regard to the interest charges on the plant. It is known what this system will do and how it can be regulated and applied, while the alternating system is in a far more experimental stage, and is a subject for consideration by electrical engineers rather than by the managers of central station plants, who have to look at the matter mainly from a business standpoint. The battery plant recently installed by his company (and put in service for the first time on June 7) is an experiment, though an expensive one, and was adopted as requiring a much lower investment than an additional generating plant and trunk line to effect the same purpose. This battery plant was described in our issue of June 9. The entire afternoon session was occupied by the continuation of this discussion and the closing remarks of the authors of the two papers.

In the evening Mr. Joseph Wetzler, of New York, delivered a lecture on "The Production of Electricity Direct from Coal." After stating that only 10% of the heat value of coal is delivered at the shaft of a steam engine, and less than 1% in an incandescent lamp, he illustrated some of the forms of apparatus which have been in use in experimental work. Although the matter is as yet purely in the stage of laboratory research the lecturer expressed the opinion that it would be operated on a commercial basis within 25 years, but the opinion of his audience evidently did not coincide with this sanguine view. When a practical system is perfected, any man can have an electric generator in his cellar and feed it once a day with coal, like the present heating furnaces, but Mr. Wetzler thought that as a matter of fact the generation would be left to large companies, as in the case of gas.

The morning session on June 9 was opened by a paper on "The Cost of Producing Electric Power by Water Power from the Lachine Rapids, Canada," by Mr. W. McLea Walbank, of Montreal. This plant, which was fully described and illustrated in our issue of Feb. 18, 1897, comprises at present 48 turbines and four General Electric three-phase dynamos, the total possible output being 16,000 K-W. There will eventually be 72 wheels and 12 dynamos. With the present plant, the cost per K-W. per year (for days of 24 hours each) is $22.97, while with the complete plant this cost will be $8.14 per K-W., delivered at the switchboard. In the discussion it was claimed that the figures given were too favorable, the plant being assumed to run constantly at full load, which is impossible. Mr. Ferguson compared this plant with the steam plant of about equal capacity at the Harrison St. station of the Chicago Edison Co. The cost of output is about $24 per K-W., as compared with $22.97 for the Lachine plant, but it was shown that coal at Chicago costs only $1.60 per ton, while at Montreal coal would have cost $3.50 per ton.

The next paper was on "Transformer Economy," by Prof. W. E. Goldsborough, of Purdue University, giving particulars of transformers tested at the University, and showing the financial gain or loss due to the use of transformers which are above or below their rated and advertised capacity. As to oil insulators, he considered that oil will deteriorate with time and heat, and that electric discharges will cause conducting compounds to form. One of the speakers taking part in the discussion, however, had found that with suitable oil in a carefully closed transformer case, there was no perceptible change after two years' service, though the oil was at a temperature of 200° for a good part of the time. The discussion then gradually drifted towards the use and efficiency of lightning arresters to protect the transformers.

At the afternoon session, Mr. James L. Ayer presented a short report from the Committee on Standard Candle-Power for Incandescent Lamps. Tests made at the Massachusetts Institute of Technology show that so-called 16-c. p. lamps range from 10 to 16.9 c. p., the average being about 14.5 c. p. The committee recommended that the lamps should have from 15.5 to 17 c. p. in a horizontal direction, and 85% of this when inclined 45°. The report was adopted and the committee discharged, a new committee being appointed to consider the standard specifications for and candle-power of incandescent lamps. The Committee on "Legislation Concerning Theft of Current" had no report to make, owing to a misunderstanding on the part of the members of the committee as to who was to do the work. The committee was changed and will prepare a compilation of the laws of 27 states. It was stated that Georgia has passed a brief law covering the conditions, and it was also suggested that as some judges have ruled that electricity is too intangible to be stolen, it would be well to make the improper tapping of wires a misdemeanor.

The proceedings closed with the election of officers, which resulted as follows: President, A. M. Young, Waterbury, Conn.; First Vice-President, E. H. Rollins, Denver, Colo.; Second Vice-President, F. A. Gilbert, Boston, Mass.; Secretary and Treasurer, George F. Porter, New York city; Master of Transportation, C. O. Baker, Jr., New York city; Executive Committee, Samuel Insull, Samuel Scovil, E. H. Atkinson, F. A. Copeland, John A. Seely, A. J. DeCamp, E. H. Stevens, W. W. Bean and W. McLea Walbank.

BOOK REVIEWS.

A GENERAL FREIGHT AND PASSENGER POST.—A Practical Solution of the Railway Problem. By James Lewis Cowles, Member of the Connecticut Bar. 3d edition. Revised and enlarged. New York: G. P. Putnam's Sons. Cloth; 12mo.; pp. 312. $1.25.

We are forcibly reminded as we look over the pages of this volume of the old and wise saying "that a little knowledge is a dangerous thing." The author has devoted a considerable amount of study to the subject of which he writes, but it is apparent that he has studied with the purpose of confirming his own preconceived notions and not with the sole idea of ascertaining the truth. According to Mr. Cowles the railway system of the United States is very much out of joint. The people are being robbed by the railways, and something must be done to remedy it. Here is his scheme: Let the government buy the railways of the country, or rather take possession of them, guaranteeing to their stock and bondholders an annual return on their securities equal to the average annual return for seven years past. The government is then to operate the roads through the medium of the post-office department and the Interstate Commerce Commission, and the unique feature of the plan is the manner in which rates of fare and freight are to be fixed. Three classes of passenger trains are to be run, designated as "Local," "Express" and "Fast Express," and the fare per trip on these will be 5 cts., 25 cts. and $1 respectively, regardless of distance, although the "trips" must be continuous trips in one direction with no stop-overs. The freight classification is more intricate, but we may remark that the "postage" as the author calls it, is to be $6 "per haul" per car load for freight hauled in box cars. On smaller quantities the rate per 100 lbs. will be 5 cts., and 2½ cts., for "box car" and "open car" freight respectively. It must be understood that these rates are absolutely irrespective of distance, and the author devotes a great part of his work to quotations from many excellent authorities to prove that the cost of railway transportation does not vary with the distance. His argument is so plausible that it is likely to deceive many, although it is based on such extravagant misapprehensions and misunderstandings that it is difficult to see how a sane man could have written it. It is interesting to note, however, that a bill to carry into effect the author's scheme was introduced in the House of Representatives Dec. 8 last, by N. D. Sperry, of Connecticut.

The book is simply another addition to the many which have been written proposing Quixotic schemes for settling what their authors call the railway problem. The great trouble with the author, as with others who have written in a similar strain, is his profound and fundamental ignorance of most of the foundation facts relating to his subject. It is a great pity that those who aim to undertake the heroic task of reforming the railway system will not take the trouble to study their problem from the inside instead of the outside. Study railways instead of sensational newspapers. Get facts and not misleading guesses. If such a course were honestly pursued, such incendiary books as the one before us would never be written, at least by a man in possession of his reason. The railway system of the United States is not perfect. Few things are in this world. But it is our candid belief that it is vastly nearer perfection than it would be if Mr. Cowles were given autocratic power to engraft upon it his own ideas.

THE LOCOMOTIVE LINK MOTION.—By Frederick A. Halsey, Associate Editor "American Machinist." Press of Locomotive Engineering, 256 Broadway, New York. 8vo.; cloth; pp. 81, with 46 illustrations.

Mr. Halsey is well known to students of mechanical engineering from his excellent little work on "Slide Valve Gears," published some years ago, and from his frequent contributions to technical literature in the columns of the "American Machinist" and elsewhere. The purpose of the present work is explained in the preface as follows:

The study of link motion embodied in this book is the result of an invitation from the Schenectady Locomotive Works to use the facilities of those works in preparing a comprehensive account of the present day practice in link motion construction. It was undertaken with that only in view, but it resulted in the discovery of two hitherto unsuspected errors in the motion, and of the fact that the effect of the angular vibration of the connecting rod, instead of being a disturbing factor, is in reality a corrective factor.

The two errors referred to are those due to the location of the eccentric rod pins back of the link arc and to the angular vibration of the eccentric rods, which errors, combined with the one due to the connecting rod, give a final or residual error which is corrected by locating the saddle stud back of the link arc.

It is believed that the articles resulting from this investigation present for the first time a true analysis of the movement of the link, as well as a correct explanation of the action of the saddle stud when located, as is universal, in the rear of the link arc.

In view of the repeated criticisms of the link motion as a mere makeshift, and of the half-hearted defense of it in reply to these criticisms, the author has included a statement of its properties and their applicability to locomotive conditions, with a view of showing that the criticisms are uncalled for and defense unnecessary.

The author continues the same line of thought in his introductory chapter as follows:

Probably no conspicuously successful mechanical device has ever been assailed so persistently as the locomotive link motion. The steam distribution which it gives is so unlike what is considered best in stationary practice, and so like what is considered bad in that practice, that many engineers have regarded it almost with contempt as a device whose only redeeming virtue lay in the fact that it kept going. It is altogether probable, however, that these opinions are mistaken ones, and that the link motion comes little short of being all that can be desired for a locomotive valve motion. The locomotive works under conditions peculiar to itself; it must in consequence be studied by itself, and conclusions based upon experience with stationary engines have little or no applicability to it.

It is rather surprising that it has required about 70 years, from the time the Stephenson link was first used, to make the peculiarities of its action thoroughly understood, and that at this late date it should be discovered that the motion contains two hitherto unsuspected errors, which act in an opposite direction to and are corrected to some extent by the angular vibration of the connecting rod; while the residual error is corrected by locating the saddle stud back of the link arc. Mr. Halsey's method of treatment of the subject is that of the drawing board, with the use of the Bilgram diagram. It is difficult reading for anyone not already acquainted to some extent with the influence of the link motion upon the lead and port opening of the valve, but the book is one that should be of great service to the practical designer of locomotive valve gear and to the student who wishes to obtain a thorough comprehension of the subject. Some interesting tables are given showing the practice of the Schenectady Locomotive Works in equalizing, for any given position of the link, the lead, the valve opening and the cut-off at the two ends of the cylinder. Some indicator diagrams are also given, which show the benefit of negative load at full gear.